AMERICAN GAS JOURNAL

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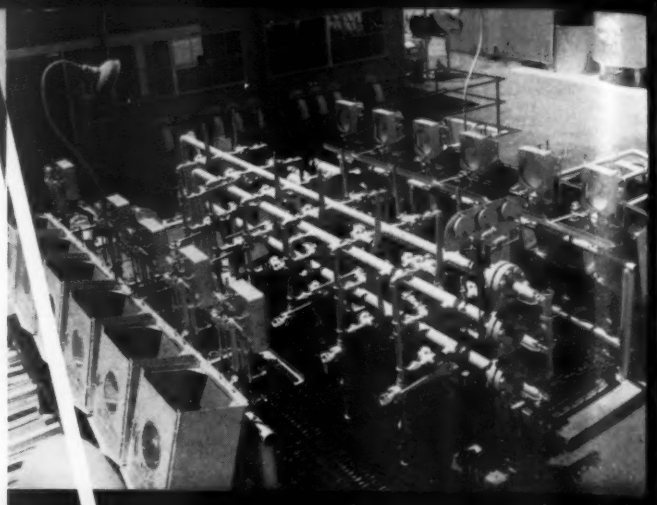

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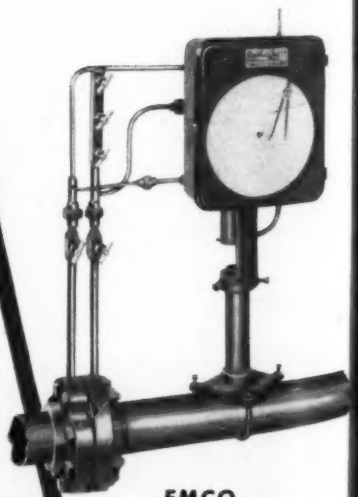

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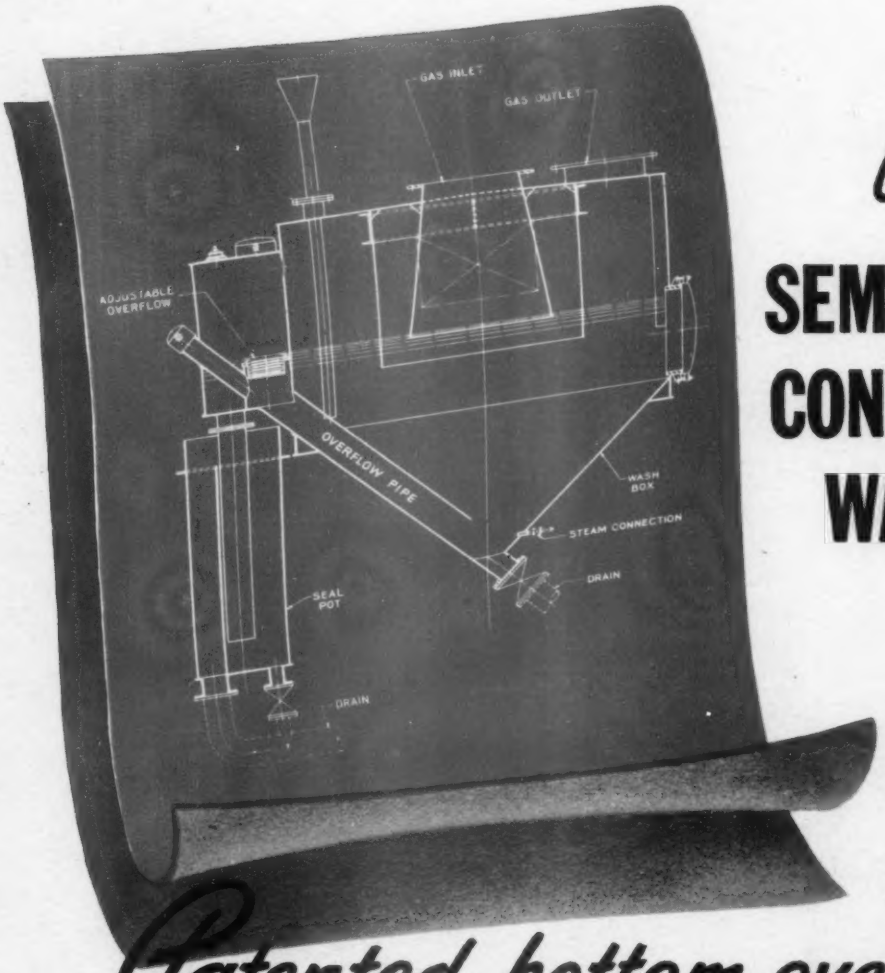

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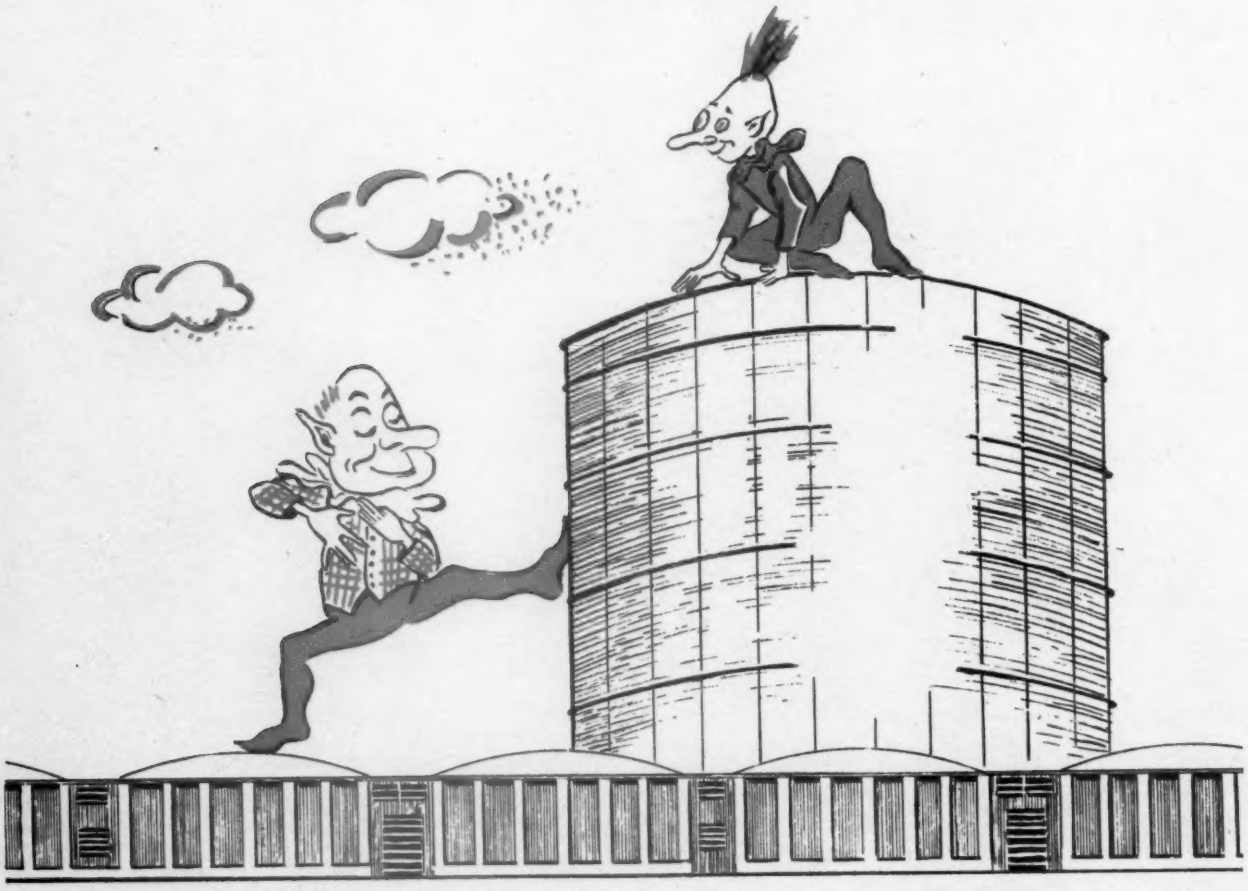

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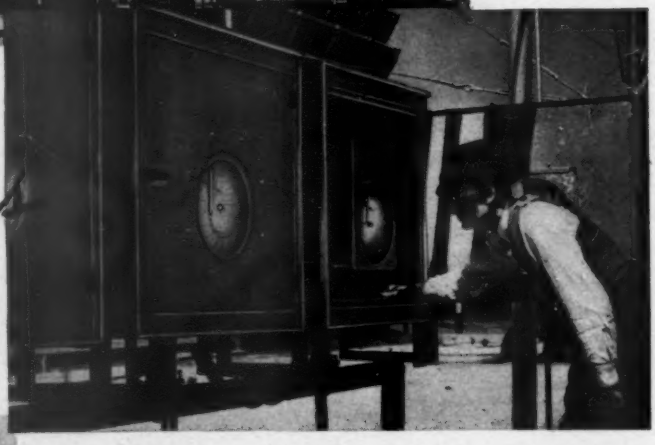

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VOLUME 158
NO. 5

Gas Pressure Regulation for Industrial Service

By
C. C. Abbott
Pittsburgh Equitable Meter Co.

THE INDUSTRIAL Gas Field, in common with other phases of our industrial life, has been greatly affected by our war activities. It was among the first to respond to the demands of our war production because, as a basic fuel, its application has been enormously broadened both in volume and scope of use. Increased consumption, combined with more exacting combustion requirements for specialized production, has presented a multitude of problems, all of which have been solved promptly and effectively. Problems of long standing, such as production and distribution, have been met by methods which are fully understood, but some new problems in the field of combustion control have required special attention.

Gas, as a fuel, is being employed so widely both by those accustomed to its use as well as those who have lately adopted it that a discussion of equipment used for gas pressure regulation, will be of interest undoubtedly to many gas users. The reasons for gas pressure regulation in order of importance, can be stated as Safety; Accurate Measurement; Economic Operation; and Efficient Combustion.

With the reasons for pressure control established, consideration can be directed to the means of obtaining this desired pressure control. The device employed to perform this function is called a regulator because it operates to regulate or control the gas pressure in the conveying system.

I—Regulator Design

Fundamentally, a regulator is a resistance installed in the flowing stream of gas. It accepts gas at a certain pressure and automatically reduces by throttling to a lower pressure. The latter is the desired pressure which is controlled automatically to a desired standard.

Essentially a regulator is composed of two elements—first, an element which may be termed the responsive member and, second, the throttling member. The responsive member is governed by the controlling pressure which is established by comparison to a standard. The throttling member is controlled by the responsive member and acts to increase or decrease the flow rate to meet the demand of the system as reflected by the pressure at the regulator outlet.

In a conventional regulator the responsive member is the diaphragm. The standard to which the control pressure is compared may have several forms such as a direct weight; a lever and weight system; a tension or compression spring; or a loading air or gas pressure, all of which are applied to the diaphragm in a manner to oppose the control pressure. When the two forces, that is, the force of the "Standard" and the force of the "Control Pressure" are in balance, the position of the diaphragm remains fixed. When the control pressure changes due to a variation in the outlet pressure system, the forces become unbalanced and a movement of the diaphragm occurs.

The fundamental principle of operation of all regulators is the same. The controlling pressure causes a change in the position of the responsive element which in turn changes the position of the valve or valves and this change results in an increase or decrease in the flow rate which results in an increase or decrease of pressure in the conveying system. While attention is generally focused on pressure control when regulators are being considered, it is well to remember that flow rate is the quantitative element which must be governed. Since pressure is developed by the quantity of the gas admitted to the system, it follows that the pressure may be taken as representing the flow and, consequently, by maintaining control over the pressure, control is thereby maintained over the flow rate as established by the consumption of gas at the point of utilization.

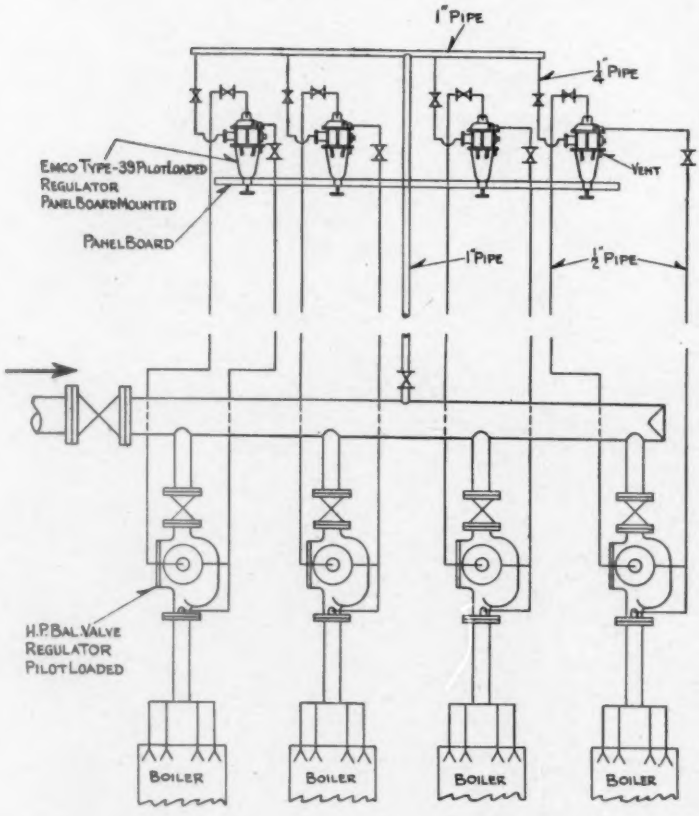
The detail specifications of the various elements employed in a regulator are established by the requirements of the individual service to which the regulator is applied. In a general discussion these elements can be treated separately without reference to any particular service or operating specifications because certain fundamentals are common to all services.

II—Selection of Regulators

1—General—Specifications for a regulator should be very carefully prepared and all influencing conditions, information and data should be submitted to a manufacturer when inquiries and also orders are to be considered. When former experience is available, the particular type and size of regulator can be specified, but where applications are to be made for regulators to operate under conditions which vary from past experience, complete information should be supplied to the manufacturer. The specifications should include a description of the service, a statement of the performance characteristics which are desired, and explicit data on the operating conditions.

2—Service—Regulators for industrial service may be of the reducing type where some higher pressure is reduced to a lower pressure; back pressure type or inlet pressure control where the regulator is used as a relief valve to maintain a constant upstream pressure; or for zero control. The latter type of service is employed on pressure burners where the air and gas are maintained at proportional pressures at the mixer inlet. As a rule, such regulators operate upon the differential principle with the burner air pressure applied to the regulator diaphragm so that the gas pressure is maintained in proportion to the air pressure. Generally the gas pressure is the same as the air pressure, although the ratio of these pressures can be varied to produce comparatively lean or comparatively rich mixtures. In such systems it is only necessary to control the air pressure in order to maintain complete control over the supply to the burner.

3—Performance Requirements—The efficiency of regulation control varies with different types of regulators. The performance characteristics are well established by manufacturers and comprehensive information is available on this point. Some regulator designs assure very constant control of outlet pressures, while other conventional designs permit reasonable variations from the regulator setting. If the service requires exceptionally accurate control, the degree of regulation accuracy should be specified. The most acceptable practice is to specify the regulator outlet pressure setting for a specified flow rate and indicate the variation from the outlet pressure setting which can be permitted at other flow rates lower and higher than the setting flow rate. A conventional regulator which permits slight variations in outlet pressure depending upon flow rates, as a rule performs in a manner which causes the outlet pressure to increase slightly below the setting flow rate and to decrease slightly for flow rates higher than the setting point. When regulators are to operate over a wide range of flow rates, it is best to set the outlet pressure for the average flow rate conditions. For example, if a regulator is to operate from 10 per cent to 100 per cent flow rate, it is advisable to make the outlet pressure setting at a flow rate of approximately 55 per cent, because the variation from the setting point will then be equally balanced above and below the setting flow rate. If the outlet adjustment is made at the higher limit of the flow rate, then the maximum variation from the desired setting occurs.



A typical layout for a boiler installation where regulators of large capacity are required for operating from supply lines carrying comparatively high pressures. These particular units are provided with a standard pilot loading system which maintains very accurate control of the outlet pressure. Since the Pilot Loading Regulator is a separate integral unit, it is very convenient to install this regulator on panel board mounting where it is easily accessible to the operator for adjusting gas pressures as the boiler loads vary.

4—Operating Conditions—Information covering the actual conditions of operation are of vital importance and must be prepared in complete detail.

(a) Kind of Fluid—Air or Gas. If gas is to be regulated, the kind of gas must be specified and also its specific gravity because the specific gravity has a decided influence upon the capacity calculations. As a rule, published regulator capacities are based on gas of 0.60 specific gravity. While slight variations from this gravity do not result in a serious departure from the capacities, it must be remembered that wide variations in gravity do produce a marked influence on the volume specifications.

(b) Pressures—Specifications must include inlet pressure and outlet pressure. The minimum and maximum should be specified for both inlet and outlet pressure. In connection with the pressure conditions, it must be remembered that the capacity of the regulator must be based upon the minimum differential between inlet and outlet, because it is this difference in pressure which causes the flow of gas through the valve orifices. In addition, the maximum inlet pressure is of importance in order to pro-

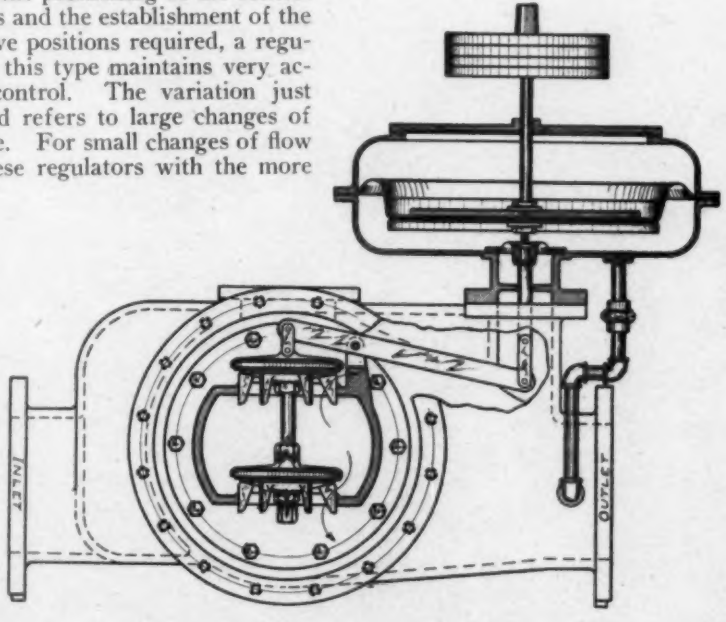
vide a regulator construction of sufficient strength to withstand the highest inlet pressure which will be applied. The range of the outlet pressure is of equal importance because the various control mechanisms are designed for certain ranges of outlet pressure setting. For example, in the case of spring-loaded regulators, more than one size of spring is generally available, but each size is designed for a certain outlet pressure range.

(c) Flow Rates—The maximum and minimum flow rate is an essential factor because the regulator must be sized for the maximum flow rate under the conditions specified and in cases where exceptionally low flow rates are required, these conditions must be specified in order that a regulator with the proper performance characteristics can be selected. In some installations the pressure control regulator is required to operate with acceptable accuracy under the highest flow rates and, in addition, it must maintain the very low flow rates required when only pilot lights are burning. For industrial regulation, it is not as a rule, customary to provide a regulator which will shut off completely and automatically when the burner valves are closed. Complete shut-off can only be provided by soft seat type valves and since installations should always be provided with pipe line shut-off valves, it is not customary to expect the regulator to lock off when the burner valves are closed. Whenever the gas-burning unit is to be closed down, the shut-off valve in the pipe line on the inlet of the regulator should be closed. If the shut-off valve on the outlet of the regulator is closed without closing the inlet valve, the inlet pressure will be permitted to build up through the regulator, and thus subject the diaphragm control mechanism to excessive pressures.

(d) Regulation Accuracy Required. This point should be covered carefully, especially if the burner equipment is of a type which is designed for sensitive adjustments. Any sudden surges in inlet pressure which may occur on the inlet of the regulator or which may occur at the outlet of the regulator due to suddenly closing of the outlet line should not be considered as a failure of accuracy in the regulator. Whenever the flow rate must be varied by the operation of valves on the outlet of the regulator, it is highly desirable to close the control valve slowly rather than by a quick action. The regulator operating mechanism must have sufficient time to respond to the changes in pressure. While the conventional regulator responds promptly to a change in the control pressure, it is possible either by manual or by automatic operation to close the discharge valve so quickly that the regulator does not have sufficient time to close the valves in order to prevent an excessive flow into the outlet line which is sufficient to build the pressure to a point which is decidedly above normal. When flow rates are increased in the outlet line it must also be remembered that the regulator must have time to respond to the change in the control pressure. If the outlet valve is opened quickly, the pressure will be suddenly lowered and cannot be built up to normal until the responsive member of the regulator operates to open the valves sufficiently to establish the new flow rate which is required to maintain the pressure setting. While this variation of large amounts in pressure is sometimes considered in studying the accuracy of a regulator, it should more properly be classified as regulator sensitivity, which is entirely foreign to accuracy of performance. Some regulators which employ a control means to maintain exceptionally constant pressures are less responsive to changes of outlet pressure and, consequently, are less sensitive. However, after the necesary changes take place in the positioning of the control members and the establishment of the new valve positions required, a regulator of this type maintains very accurate control. The variation just discussed refers to large changes of flow rate. For small changes of flow rate, these regulators with the more sensitive controls respond so promptly that no change in outlet pressure occurs.

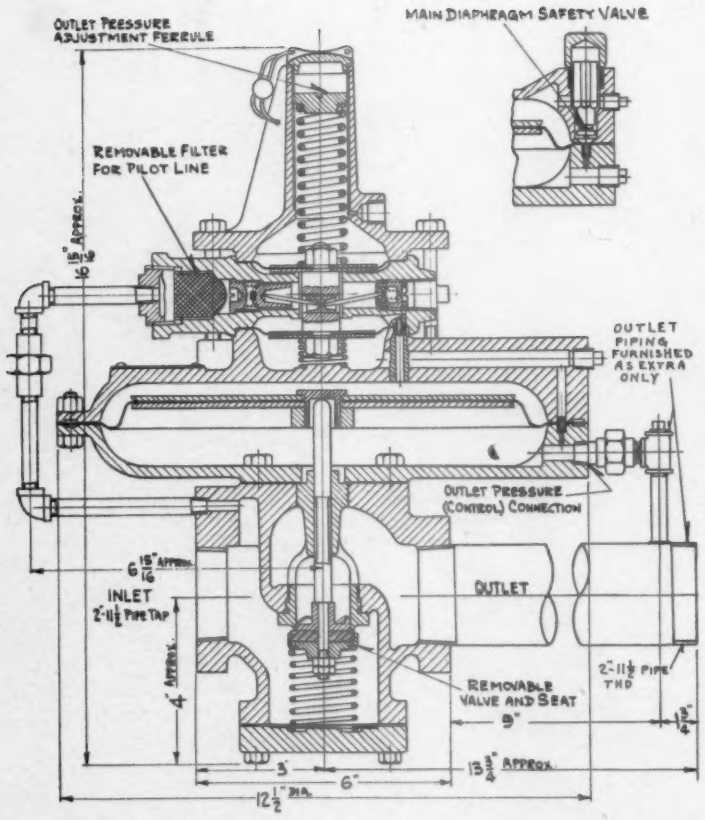
(e) Type of Control—Several methods of controlling the position of the operating diaphragm are employed. The selection of the proper control depends entirely upon the results desired. In the conventional regulator design for average operating conditions, the diaphragm may be controlled by a lever and weight system; a weight applied directly to the diaphragm; and a spring generally of the adjustable type which is also applied directly. Regulators which must operate with exceptionally accurate control are frequently provided with a pilot loading system in which gas from the inlet side of the regulator is supplied to the space above the main control diaphragm by a small pilot loading regulator, the position of which is controlled by the outlet pressure desired on the main regulator. The pilot loading regulator, as a rule, is designed to be adjusted in order that different outlet pressure settings on the main regulator may be obtained.

The outlet pressure control is, as a



A standard low pressure type reducing regulator for reducing gas pressure in pounds to outlet pressures measured in inches. This type is used on medium and large capacity service. The outlet pressure may be changed by adding or subtracting the number of weights on the diaphragm mechanism.

This system of regulators is used for zero control by applying a lever and weight system to counter-balance the weight of the diaphragm and linkage. When constructed in this manner, it may be balanced to obtain zero gas pressure as compared to atmospheric pressure, or the upper case may be piped for an air pressure which is used as a control pressure for maintaining an air-gas ratio.



A regulator for medium and small flow rates where the supply pressure in pounds must be reduced to a lower pressure in pounds or to inches water column. This construction provides exceptionally close control of the outlet pressure due to the fact that it employs a pilot loading system. The outlet pressure of the main regulator is controlled by adjustment of the small pilot regulator mechanism and the pilot gas which flows through the small regulator is discharged directly into the outlet line of the main regulator.

rule, obtained by conducting the pressure obtained at the outlet of the regulator directly to the lower diaphragm case. However, some installations may be arranged in a manner which makes it advisable to consider remote control. In such cases the control pressure is communicated to the diaphragm chamber from a point downstream from the regulator. This method is used only when the regulator is located at a considerable distance from the burner installation. By employing remote control, the response to changes at the point of utilization is conducted quickly to the operating mechanism of the regulator and thus provides greater sensitivity to the changes in pressure which are required to maintain the desired flow rates for the burner. When remote control is used, the connections at the control point should be carefully located. The connections should be made at a point where the flow stream is constant in its characteristics and not at a point where there is undue turbulence in the flowing gas. Turbulence is always present adjacent to any turns in the gas stream and also adjacent to any valves or reductions in pipe line size which change the flowing characteristics of the gas stream.

Proportional loading controls are sometimes employed, as mentioned for zero control governors. The proportion may be desired between two gas pressures or between an air pressure and a gas pressure. In these cases, the air or gas pressure which is the controlling element of the system, is applied to the upper diaphragm case and the regulator is constructed so that the control diaphragm is positioned by the ratio of the controlling pressure above the diaphragm and the pressure below the diaphragm, which is usually taken immediately at the regulator outlet.

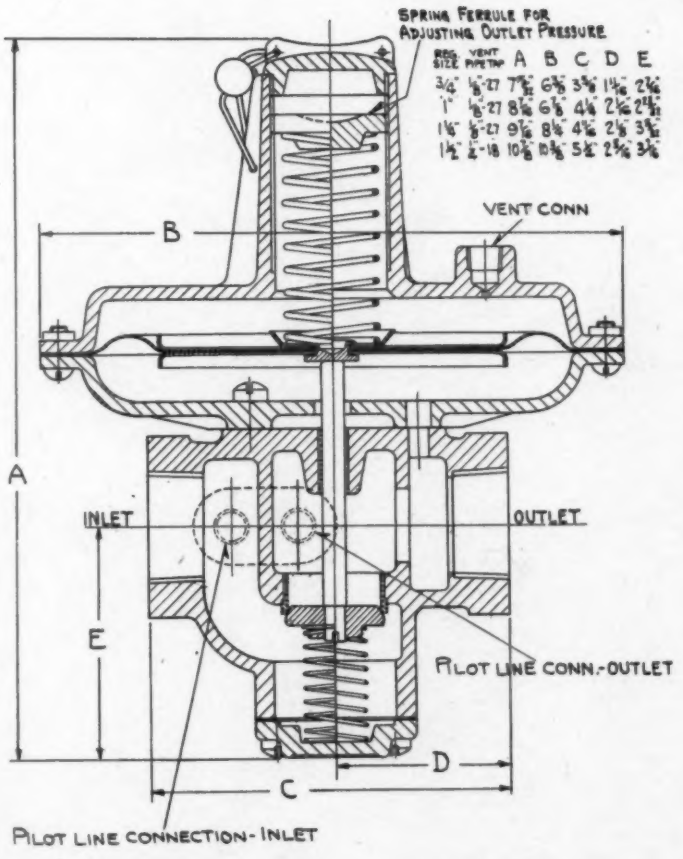
(f) Burner Control—Burners are logically classified, so far as control is concerned, in two groups: First manual control; and, second, automatic control. In the former, control is maintained on the burners as indicated by the classifications, that is, the control valve is operated manually for the desired conditions of combustion. In the automatic control, the gas burner valve is controlled automatically by a temperature element or instrument. These valves may be either snap-acting or slow-acting. The former is generally operated by an electric solenoid and the latter is constructed with a diaphragm motor operator which opens and closes the gas burner valve slowly. Snap acting valves cause extremely sudden fluctuations in the flowing stream of gas to the burner and place a very severe operating condition on the regulator. In the slow opening and closing valves, the pressure changes are more gradual and the regulator, therefore, can respond with the desired degree of sensitivity, thus avoiding sudden fluctuations and surges in the gas pressure between the regulator outlet and the burner.

(g) Size and Type of Connections. While this specification may be omitted, it is preferable to state the size of pipe line in which the regulator will be mounted because, as a rule, the size of the gas lines are determined before the regulator is considered in order to meet the required carrying capacity for the gas which is to be utilized. The smaller sizes of regulators are manufactured with threaded openings for standard pipe sizes, while the larger regulators are constructed with flanged connections. Some regulators are provided with threaded companion flanges as a matter of convenience in installation. These points should be carefully considered because several items of detail construction in the piping layout are affected.

It is incorrect to assume that a regulator should be specified for a connection which corresponds to the pipe size. While it is convenient to have the regulator connection of the same size as the pipe, it must be remembered that the regulator is a pressure reducing device and that the pressure at the outlet is controlled by throttling. Therefore, the lower pressure required on the outlet of the regulator is the result of a friction loss which is a combination of the loss in the regulator body and in the orifice and valve of the regulator. This consideration applies more gen-

erally to regulators of the larger size. Regulators for small and medium flow capacity, as a rule, are designed with connections for the average size of pipe line in which they will be installed.

(h) Low Flow and High Flow Conditions. As discussed under Flow Rates, the range of flow rate capacities should be clearly outlined. The maximum flow must be specified because the regulator size must be sufficient to meet the maximum conditions. The low flow specifications are important especially if very low flow rates will be applied to the regulator. Generally speaking, the conventional regulator will perform very satisfactorily over an exceptionally wide range of flow rates, but in some cases where the regulator must control the flow required by low consumption pilot lights, it is advisable to include in the specifications the lowest flow rate at which the regulator will be expected to operate. Where these low flow rates are less than those at which the regulator can be expected to operate with acceptable accuracy, it is advisable to use a separate supply line for the pilots and employ a small regulator designed especially for the flow rate and pressure conditions required by the pilots.



A regulator for small and medium capacity designed to reduce inlet pressures of 5 pounds maximum to outlet pressures of 1 pound or less. This regulator may be used for inlet pressure control by arranging the assembly to provide for this type of performance. It may also be used as a zero or differential control regulator by employing air or gas pressure for loading the upper diaphragm case.

III—Installation of Regulators

1—Inspection. It is advisable to carefully inspect a regulator before it is installed in order to determine whether any damage has occurred in transit or whether any foreign matter has collected in a position which will interfere with its operation. After the inspection, the regulator is ready for installation because all medium and small regulators are shipped in a completely assembled unit.

2—Location. While no definite recommendations can be stated with reference to the location of a regulator in a system, it is accepted practice to mount a regulator as close as convenient to the gas burning equipment. Naturally there is a limit to the distance at which a regulator must be installed to protect it from excessive temperatures. Since the majority of regulators are provided with sheepskin diaphragms which are subjected to special oil treatments, it is necessary that the temperature of the regulator parts never exceed 140 to 150° Fahrenheit. At temperatures above these the oil dressing in the diaphragm has a tendency to leave the sheepskin, thus making it slightly porous and eventually developing a stiffness of the diaphragm which will finally result in rupture. A serious rupture will result in the regulator becoming inoperative because it has no possibility of retaining the controlling pressure.

3—Setting. The regulator should be mounted carefully in a level position. Small regulators can be mounted directly in pipe lines without any support other than the line. Where the weight of the regulator is such that support is necessary, the foundation or setting can be made in any convenient and acceptable manner. For the larger regulators it is advisable to use substantial supports. In making the pipe connections, care should be exercised to make the connections carefully in order to insure that no pipe strain is placed on the regulator. Such strains may distort the regulator to the point where the operating parts are placed in misalignment and such a condition will naturally influence the performance of the regulators.

In order to protect against an interruption of service, it is customary to install a by-pass around the regulator in order that it may be removed from service for inspection and maintenance. For by-pass installations, valves must be mounted at the inlet and outlet of the regulator and naturally a valve must be located in the by-pass run. This valve must be of a type which can be manually operated with convenience if the gas flow must be controlled when the regulator is removed from service.

4—Venting. All regulators of the conventional type which require access to the atmosphere for the upper diaphragm case are provided with a vent opening located at a convenient point in the case. As the diaphragm raises and lowers, the air must exit or enter through this opening. As a rule, the vent openings are drilled and tapped for standard pipe so that a vent pipe can be installed for connection to a point outside the

(Continued on page 56)

Wartime Nutrition Program

Southern California Gas Utilities Home Service Departments Unite in Constructive Nutrition Campaign

By
Fred A. Herr

In peace times, the Home Service Departments of gas companies did a splendid job of educational work and good will building with the company customers. Now, with food rationing, the importance of the Home Service Department has increased many fold. This article outlines the wide scope of the educational program being carried on in the communities served by the Southern California Gas Company and the Southern Counties Gas Company, Los Angeles, California.

WITH GOVERNMENT rationing of canned goods and meats having made the people more "food conscious" than ever before in the history of the country, two Southern California gas utilities have launched comprehensive programs designed to educate the public in economic ways of preparing foods under the rationing system, which has been tied in with an extensive wartime nutrition advertising schedule.

Participating as Joint sponsors of the advertising plan are the Southern California Gas Co. and the Southern Counties Gas Co., both with headquarters at 810 South Flower St., Los Angeles.

The program is designed to provide the gas using public with authentic information on foods in general, how to cook them, plan menus and buy food which is available under the rationing systm according to its nutritive value so that meals can be properly balanced from a nutritious standpoint.

Wartime Nutrition Advertising

The program was introduced to the public in a joint advertising program sponsored by the two companies. The first of a series of advertisements appeared in Southern California daily and weekly newspapers the week of February 22. The initial copy summarized the objectives of the program in the following statement:

"This is the first of a series of advertisements dealing with the vital subject of food in wartime. Authentic nutritional information and helpful suggestions for cooking under wartime rationing conditions are presented under the direction of our Home Service Department. War time gas cooking saves vitamins and minerals."

Concurrently with the appearance of the first advertisement, the home service departments of the two gas companies, headed by Miss Mercedes Bates for Southern California Gas Co., and Miss Katherine Rathbone for Southern Counties Gas Co., correlated programs embracing cooking schools, nutrition classes, red Cross and Canteen Service Classes and Ration Cooking classes which were tied in effectively with the advertising series.

The wartime nutrition advertising program has been planned on an impressive scale. Beginning with the introductory announcement during the week of February 22, the schedule ran through March and has been mapped for continuance through the summer months. The schedule calls for advertisements, four columns wide by 12 inches deep, to appear once a week in the Los Angeles Examiner, Times, Morning-Evening News, Herald-Express, Hollywood Citizen-News, Los Angeles Downtown Shopping News and 15 territorial dailies in other towns of Southern California. The advertisements appear once a week in a total of 26 newspapers and twice a month in 28 weeklies.

Ads Give Ration Data

The first advertisement, which appeared before canned goods rationing went into effect, was keyed to the theme "How To Get Off To a Good Start With The Point Rationing System." It advised people to become "nutrition-wise." Valuable Pointers on how to prepare for canned goods rationing were presented. The value of nutrition was emphasized, and the operation of the point rationing system was graphically explained in seven simple statements.

A part of each advertisement is devoted to a column headed "Your Wartime Gas Kitchen Counselor." This column features practical suggestions by members of the Home Service Department of the two companies on ration cooking, discussion of ways of preparing rationed foods, and suggestions for making points in the ration books go farthest in purchasing food.

The advertisements which followed the introductory layout are four columns wide and 12 inches deep. The theme of the copy stresses a particular subject for the week. The advertisement for the week of March 8, for instance, dealt with soups. The customers were told how to spare the can opener and use nutritious leftovers and low ration point foods.

"Now's the time (the ad read) to march out the old-fashioned soup kettle and put it to work again. Into it can go good odds and ends of meat, vegetables and other left overs. And out of it will come the backbone of many a meal, a dish that's rich in nutritive value, yet hardly costs any ration points at all."

This was followed by seven pertinent suggestions on the preparation of soup, including timely hints on how to prepare soup for lunch-box thermos bottles.

Other advertisements in the March series dealt with the following themes:

How to budget your ration points to be sure of having nutritious, balanced meals all month long.

Eggs—every one a perfect package of nourishing good health.

How you can make the most out of your ration of meats.

Wartime Gas Kitchen Counselor

The Wartime Gas Kitchen Counselor column which is part of each advertisement is devoted to supplementary timely hints pertinent to the main theme of the week. No. 6 in the series, which appeared March 29th is reproduced herewith.

The name of both the Southern California Gas Co. and Southern Counties Gas Co. appears on each advertisement.

HOW YOU CAN MAKE THE MOST OUT OF YOUR RATION OF

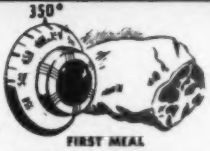
MEATS

Just remember that the more plentiful, cheaper cuts are usually as nutritious as the more expensive ones.

YOUR WARTIME *Gas Kitchen Counselor*

NUMBER 6 OF A SERIES

3 SUGGESTED WAYS TO HAVE MORE "MEAT DAYS" PER MONTH



PORK SHOULDER. This economical cut can be used to balance your nutritive meat proteins for 3 good meals. Like other meats, it's high in essential minerals and vitamins, thiamin especially.

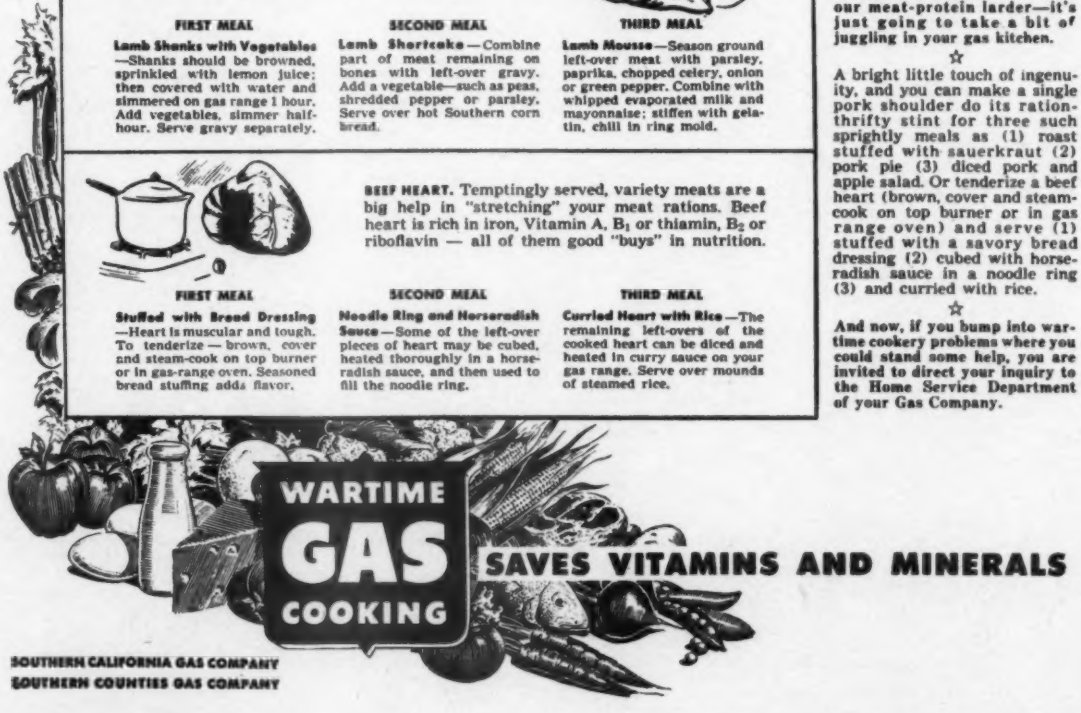
FIRST MEAL	SECOND MEAL	THIRD MEAL
Roast Stuffed with Sauerkraut—After the bone has been removed, stuff cavity with fresh sauerkraut. Roast at 350° in your gas oven to retain mineral-and vitamin-rich juices.	**Pork Pie**—Cube part of left-overs in alternate layers with sliced, cooked sweet potatoes and onions. Add gravy diluted to 2 cups. Top with pastry dough. Bake in casserole.	**Pork and Apple Salad**—Combine diced bits of pork shoulder with cubes of celery, walnuts and unpeeled apples. Can be served in hollowed-out cabbage head or in lettuce cups.

LAMB SHANKS. Remember that the cheaper cuts of meat, such as lamb shanks, have approximately the same nutritive value, and in some instances, a higher nutritive value than the more expensive cuts.

FIRST MEAL	SECOND MEAL	THIRD MEAL
Lamb Shanks with Vegetables—Shanks should be browned, sprinkled with lemon juice; then covered with water and simmered on gas range 1 hour. Add vegetables, simmer half-hour. Serve gravy separately.	**Lamb Shortcake**—Combine part of meat remaining on bones with left-over gravy. Add a vegetable—such as peas, shredded pepper or parsley. Serve over hot Southern corn bread.	**Lamb Mousse**—Season ground left-over meat with parsley, paprika, chopped celery, onion or green pepper. Combine with whipped evaporated milk and mayonnaise; stiffen with gelatin, chill in ring mold.

BEEF HEART. Temptingly served, variety meats are a big help in "stretching" your meat rations. Beef heart is rich in iron, Vitamin A, B_1 or thiamin, B_2 or riboflavin — all of them good "buys" in nutrition.

FIRST MEAL	SECOND MEAL	THIRD MEAL
Stuffed with Bread Dressing—Heart is muscular and tough. To tenderize — brown, cover and steam-cook on top burner or in gas-range oven. Seasoned bread stuffing adds flavor.	**Noodle Ring and Horseradish Sauce**—Some of the left-over pieces of heart may be cubed, heated thoroughly in a horseradish sauce, and then used to fill the noodle ring.	**Curried Heart with Rice**—The remaining left-overs of the cooked heart can be diced and heated in curry sauce on your gas range. Serve over mounds of steamed rice.



SOUTHERN CALIFORNIA GAS COMPANY
SOUTHERN COUNTIES GAS COMPANY

After building our menus around meats all these years, the wartime meat scarcity has thrown a lot of us into a dither.

☆

But be of good cheer. We can still expect to have our meat rations, and you may be surprised at your cunning in stretching them out, and at the gastronomic wingdings you can concoct from the more plentiful, cheaper cuts and so-called "variety" meats.

☆

Nutritionally speaking, meat happens to be one of the best sources of "complete" protein, and that's the stuff that builds and repairs muscles. But there are other sources—milk and milk products, eggs, fish and poultry, for example. And we still have up our sleeves the "incomplete" protein foods such as dried peas, beans and lentils, nuts, cereals, breads and pastes like macaroni. We can use all these to extend our meat-protein larder—it's just going to take a bit of juggling in your gas kitchen.

☆

A bright little touch of ingenuity, and you can make a single pork shoulder do its ration-thrifty stint for three such sprightly meals as (1) roast stuffed with sauerkraut (2) pork pie (3) diced pork and apple salad. Or tenderize a beef heart (brown, cover and steam-cook on top burner or in gas range oven) and serve (1) stuffed with a savory bread dressing (2) cubed with horseradish sauce in a noodle ring (3) and curried with rice.

☆

And now, if you bump into wartime cookery problems where you could stand some help, you are invited to direct your inquiry to the Home Service Department of your Gas Company.

The Southern California Cas Co. and Southern Counties Gas Co. of Los Angeles have entered wholeheartedly into a program for advising their clientele on wartime nutrition under food rationing.

A collaborative advertising campaign was launched on February 22 by the two companies which calls for display ads in 26 daily newspapers of Southern California once a week, and in 28 weeklies twice a month.

Typical advertisement (4 col. x 8 in.) is shown above. This appeared during the latter part of March. The advertisement for each week is centered about a single subject—meats, soups, eggs, canned goods, etc.

Replacement Foods Recommended

The Southern California Gas Co., under the direction of Miss Mercedes Bates, is conducting a series of cooking and nutrition classes which have been tied in effectively with the advertising program sponsored jointly by the two gas firms.

The classes feature instruction on alternate or replacement foods which can be used for items off the market or in which a temporary shortage exists. When eggs were scarce in Los Angeles during the early part of 1943, the gas company classes recommended food items of corresponding nutrition value, such as fish, milk and cheese, and class instructors presented timely advice on how to prepare tasty dishes from those products.

Weekly Red Cross Nutrition classes are conducted by the Southern California Gas Co. in a 10 week series in the company auditorium, 821 South Flower Street, Los Angeles, as well as at its Inglewood, Glendale, Hollywood, Huntington Park, San Bernardino, Redlands and Banning offices at Palm Springs and at Visalia and Hanford. The classes consist of six lessons and are given in cooperation with the American Red Cross. Those who complete the courses in nutrition receive a certificate equivalent to half credit on the regular certificate issued by the Red Cross for nutrition work.

The company also conducts evening classes in nutrition for business girls who are unable to attend the day classes.

Another phase of the firm's activity is the Canteen Service Class in which fundamentals of nutrition are taught in 20 hours of instruction spread over ten weeks. Instruction in quantity food preparation is one of the features of this class. Persons must graduate from the Canteen Service Class before they are eligible to join the Red Cross Nutrition Class.

Ration Cookin' Classes

A timely series featured by the Home Service Department of the Southern California Gas Co. is called "Ration Cookin' Classes." They have proven tremendously popular since rationing of canned foods and meats became an actuality. The first series of six classes was held in March under the auspices of Los Angeles, Alhambra and Pasadena chapters of the Red Cross, using the auditoriums and cooking demonstration facilities of the gas company and its branches. Average attendance at Ration Cookin' Classes is reported to be 70 to 80 women per class. A new series of classes started on April 1.

Planned as a flexible course designed to give those attending the latest information on the food picture in Southern California, these classes also present methods of using food alternates to produce the highest possible nutritive values.

Southern Counties Gas Co.

The Southern Counties Gas Co. likewise has underway an extensive program for tieing in the work of its Home Service Department with the current wartime nutrition advertising campaign.

Under the direction of Miss Katherine Rathbone, Home Service Director, and the general supervision of Clyde H. Potter, general commercial agent, Southern Counties Gas Co. is conducting nutrition classes in cooperation with the American Red Cross. Simultaneously an expanding program is underway by this company to disseminate general information on food preparation, food values, proper cooking methods, substitute foods and the like, as an aid to housewives in providing for their families under wartime conditions.

In the firm's Santa Monica Division, a 10-week Red Cross nutrition course is supplemented by a series of special nutrition conferences. Since March 10 a one-hour nutrition conference has been held in the morning and afternoon of Wednesday and Friday of each week. Advice on point rationing is given at these conferences to anyone who cares to attend, and hints and instruction are given on food preparatin under the point rationing system.

In Southern Counties Gas Co.'s Orange County District, plans have been completed for conducting nutrition classes throughout April and May in Laguna Beach, Balboa, Costa Mesa, Anaheim and Fullerton. Similar classes are held in Pomona, Claremont, Glendora, Upland and Chino in the Eastern District; in Santa Maria, Lompoc, Paso Robles, San Luis Obispo and Arroyo Grande in the Northern District; and in San Pedro, Wilmington, Harbor City and Dana Strand in the Harbor District. The company reports that recent classes at Arroyo Grande have been especially noteworthy in that class enrollment totaled 300 in a town with a population of 1100.

Nutrition Classes in War Plants

In some of the districts the Southern Counties Gas Co. is conducting noon hour classes for the benefit of workers in war plants. In these classes the "lunch box" approach to nutrition is used. Workers are advised on how to prepare balanced diets for their lunch boxes. In some plants short nutrition programs are staged in the employees' cafeteria or lunch room.

Programs of that type, Miss Rathbone reported, have been given on a large scale for employees of the California Shipbuilding Corp. at Terminal Island in the Los Angeles Harbor District, at the Douglas Aircraft Co.'s plant in Santa Monica, and at other large war plants.

An expansion of its nutrition instruction program will be undertaken by the Southern Counties Gas Co. on June 1 when the first of an eight week series of classes will be held to give advice on oven evaporation of foods, dehydration of foods, oven canning and pressure canning.

These classes will concentrate instruction on how to preserve food for the winter. The courses will be tied in with the Victory Garden movement by offering advice on how to treat surplus foods from Victory Gardens and preserve it for fall and winter consumption.

Coal Production in U. S.

Complete data on coal producing companies in the United States is included in MacQuown's Directory of Coal Operating Companies, recently issued and available for immediate distribution. Accurate information is available on personnel, description of equipment inside and outside each mine, as well as complete data on quality of coal produced, sizes made, preparation and sales outlets.

The abnormal demand for coal due to the War Emergency and the anxiety of mine supply and equipment companies and others, to keep in touch with the rapidly changing conditions in the Industry, makes the publication and availability of the data included of considerable value.

This outstanding Directory (204 pages) is available at $7.50 a copy. Issued by National Coal Publications, 1201 Berger Bldg., Pittsburgh, Pa.

Centrifugal Pumps, Bulletin W341-B7A, issued by Worthington Pump and Machinery Corporation, Harrison, N. J., illustrates and describes in detail types H.L. and H.B.L. centrifugal pumps for moderate temperatures and pressures in polymerization, topping, cracking, lube oil, recycling, alkylation and natural gasoline plants. Sizes and capacities are listed and details featured in diagrams. Copy sent on request by general office or any district office.

WORTHINGTON

EQUIPMENT FOR THE GAS INDUSTRY

for

MAIN LINE
•
BOOSTER
•
DISTRIBUTION
•
POWER GENERATION

HORIZONTAL DOUBLE-ACTING GAS ENGINE-COMPRESSORS
for heavy duty main line service, in the larger capacities

ANGLE GAS ENGINE-COMPRESSORS
for main line, booster and distribution service, in medium capacities

VERTICAL CONVERTIBLE GAS-DIESEL ENGINES
for auxiliary station power service

UNIBLOC GAS ENGINE-COMPRESSORS
for limited space, for gas distribution service

OPPOSED TYPE MOTOR-DRIVEN GAS BOOSTER COMPRESSORS
design gives minimum shaking forces, for bad soil conditions

DUPLEX SYNCHRONOUS MOTOR-DRIVEN COMPRESSORS
for gas distribution service

GC3-6

Gas engines totaling more than three-quarters of a million horsepower now in operation

WORTHINGTON PUMP AND MACHINERY CORPORATION

General Offices: HARRISON, NEW JERSEY

Offices and Representatives in all Principal Cities

YOUR JOB—TO MAINTAIN A VITAL SERVICE ...TO CONSERVE CRITICAL MATERIALS

How to maintain a vital service to the fighting, home and industrial fronts while conserving materials is a tough assignment. Yet the job must be done. Much of the success of war production depends upon your service.

We don't pretend to have all the answers but when your job involves the maintenance, the extension or the salvaging of pipe lines, we can help. Here's how.

OUR JOB—TO HELP YOU GET EMERGENCY PRODUCTS AND REPLACEMENT PARTS

Dresser Couplings, Fittings, Repair Sleeves and Clamps, are peacetime products which have assumed war time significance.

Our Job is the production of actual fighting goods and in addition, the emergency products needed for protection, repair and extension of vital pipe lines.

Many Dresser products are still available from stock on short notice—with proper priority. Others can be made and shipped fairly promptly.

So whatever your needs, get in touch with us. Nine times out of ten we are able to meet your requirements or to suggest satisfactory alternates.

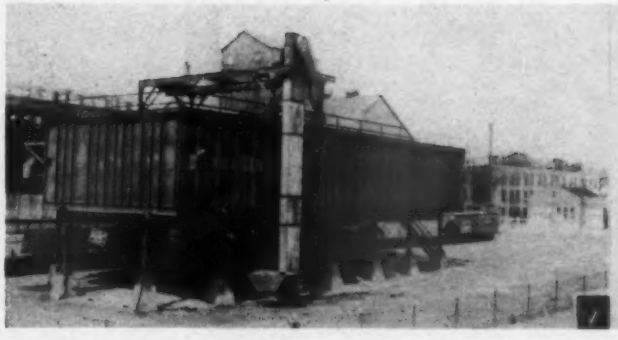
Our Job is to help you do Your Job. Write, wire or phone—

DRESSER MANUFACTURING COMPANY • BRADFORD, PA.

DRESSER PIPE COUPLINGS AND REPAIR DEVICES

Gunite Linings For Purifiers

By
J. H. Erwin
Gas Superintendent
Rockford, Ill.



THE JOB of combating corrosion in steel oxide purifiers is a difficult job at best, but during war-time conditions with restrictions on materials, it is even more difficult. To this end a description of a purifier Gunite lining construction job might be of value to other gas plant operators who may be faced with corrosion problems, or purifier replacement problems at this time.

At Rockford, Illinois, a set of three overhead steel box purifiers were constructed in 1928. These boxes are entirely welded—sides, bottoms and partitions being constructed of ¼" steel plate. The interior was protected with suitable corrosion-resistant paint. Within a very short time, this interior coating disappeared, being worn off by the contact with purifying material and due to absorption by the gas stream and condensates. Heavy corrosion set in and by 1937 we were face to face with a major repair or rebuilding job. Holes were existent entirely through the sides and partitions as well as the bottom of the box.

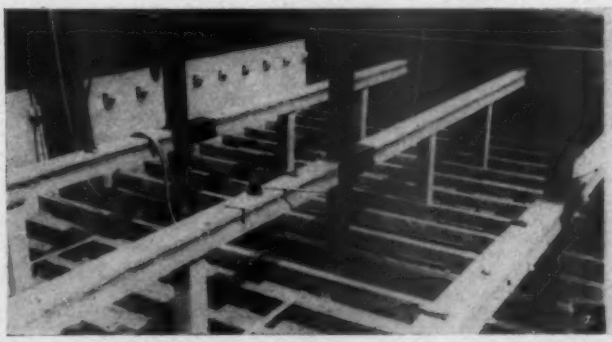
Photo Number 1 shows the general construction of the box. You will note that it is elevated. This particular type of construction presented difficulties when considering the installation of a Gunite lining. In checking the experience of others on corrosion problems of this kind, we found that Gunite linings were common, but that they were usually designed in thicknesses of five and six inches. Such a lining in this overhead box would have created extremely heavy loads and might have overloaded the columns and supporting beams under the box. We were fortunate in having an extremely good foundation, each column being supported on four concrete piles, having a capacity of thirty tons each. The design load on each column under the box was 222,700 pounds.

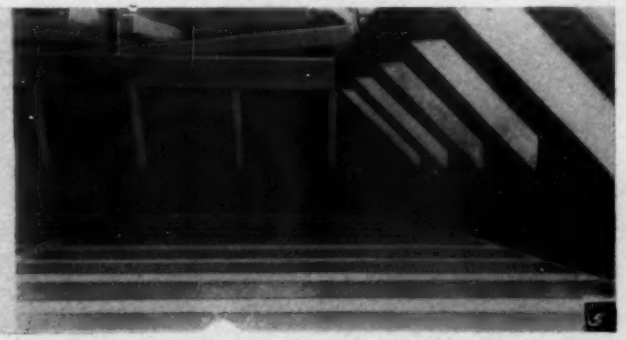
1. General view of overhead purifiers 40' x 40' x 13' three compartment box.
3. This shows wire mesh in place on tray support beams before application of Gunite.

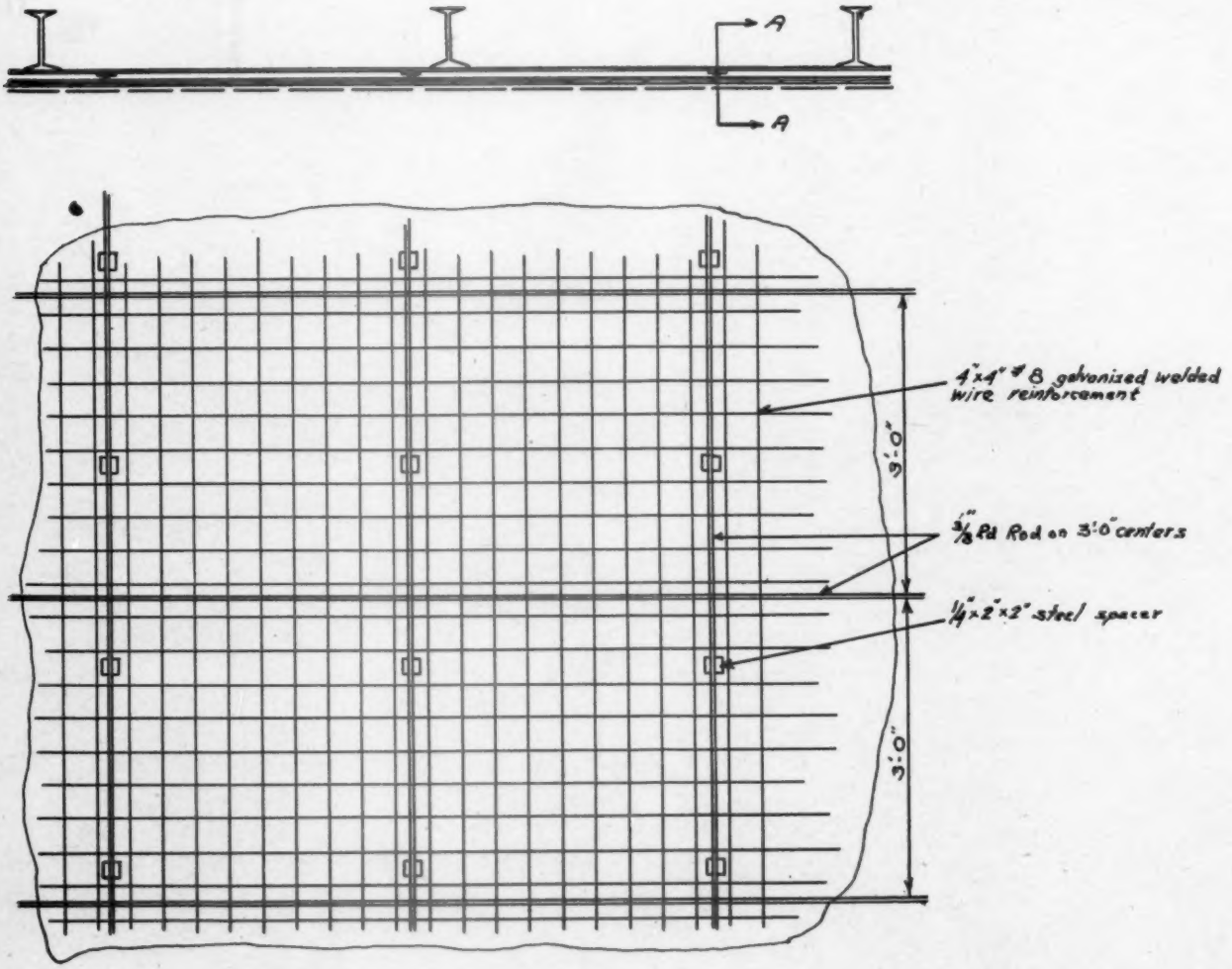
After carefully checking, it was decided to install a Gunite lining of 2" thickness, reinforcing this in such a way as to give the maximum strength. This thin lining, it was felt, would give maximum protection to the steel box and at the same time have enough mechanical strength to stand up if properly reinforced, and still would not add excessive weight to the box, causing overloaded conditions in the underlying steel beams and columns supporting the box.

Calculations indicated that the load to be added because of the addition of steel reinforcing and concrete lining amounted to approximately forty tons per box and the three units in this purifier set-up meant that we were adding 120 tons to the load on the present structure. An investigation of the stresses on the superstructure of the box showed that the transverse beams would be subjected to a stress equal to 19,200 lbs. per sq. inch. The main beams would be subjected to approximately 20,000 lbs. per sq. inch while the columns would have a stress equal to 12,000 lbs. per sq. inch. This meant that the addition of the 2" Gunite lining increased the stress above ordinary design val-

4. Gunite applied to tray support beams and columns.
5. The finished Gunite lining near top of box.







DETAIL OF GUNITE REINFORCING
SCALE 1"=1'-0"

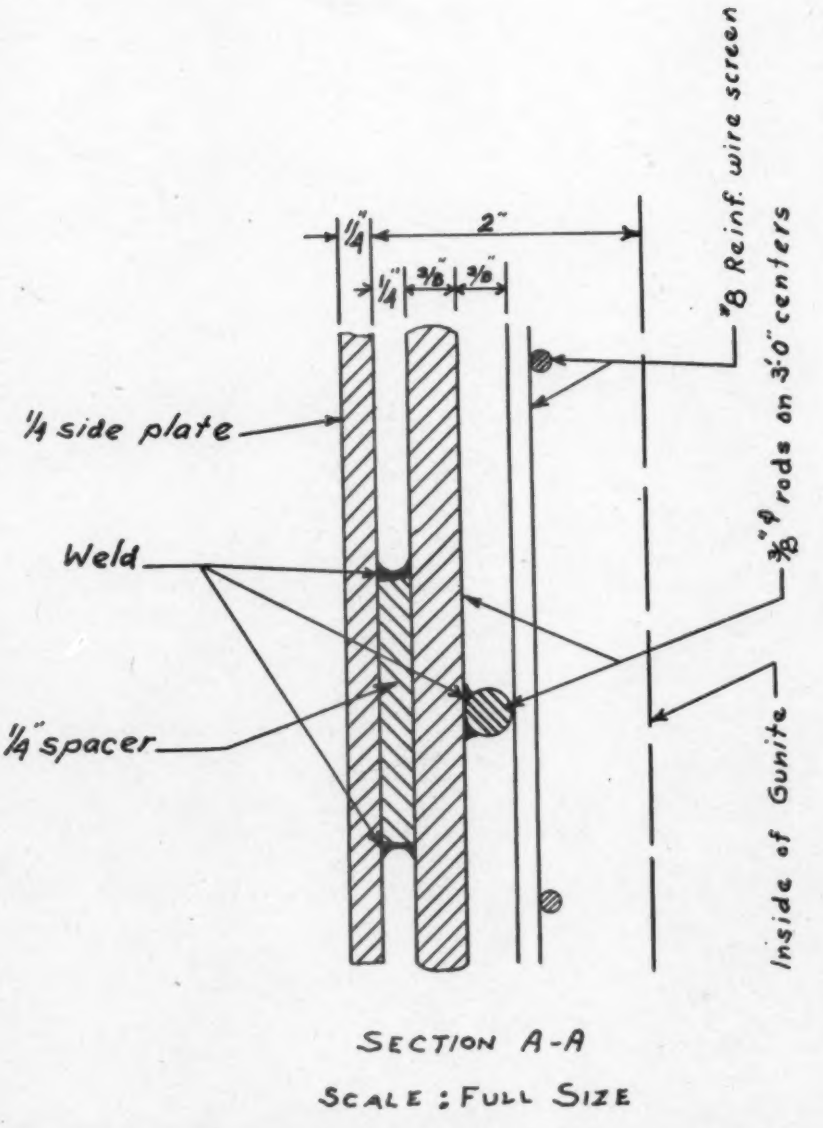
ues and reduced the factor of safety to approximately three. We felt that this still gave us an ample margin of safety and it was decided to go ahead with the installation of the lining.

A detail sketch is shown indicating the type of reinforcing installed to give the Gunite Lining maximum strength. One-quarter inch spacer plates were welded to the side of the box on approximately 30" centers to which vertical 3/8" reinforcing rods were in turn welded and crossing these at right angle, horizontal 3/8" reinforcing rods were welded. These rods being on 3 ft. centers on top of the 3/8" rods. Standard 4 x 4 No. 8 galvanized welded wire reinforcing mesh was spot welded to hold it in place. This placed the reinforcing steel approximately in the center with heaving reinforcing bars on the outside edge of the Gunite section. This, we felt, gave the maximum strength to the Gunite slab itself. A considerable amount of support, of course, came from the outside 1/4" steel plate forming the original box.

At the top edge and around openings a 2" x 2" angle was welded to form a definite stopping point for the Gunite lining. Reinforcing wire mesh was formed around the steel beams as shown in Photograph No. 3 herewith and the Gunite shot against this reinforcing mesh forming a coated beam structure as shown in Photograph No. 4. The complete view of the interior of the box is shown in Photograph No. 5. You will note the smooth, evenly coated surfaces after covering with Gunite. The concrete mixture used was one part standard Portland Cement and 3½ parts clean, sharp sand conveyed dry through the application nozzle at which point sufficient water was added to give the material a consistency which would allow it to stick when projected into place. To provide an absolutely clean surface and to guarantee against the danger of corrosion taking place behind the Gunite lining, the entire interior area of the purifier and all structural beams were completely sand blasted before any work took place.

This Gunite lining when installed in 1937 represented our best judgment as to the best method of repair available under the existing conditions. We have been more than pleased with the service rendered by this purifier since that time and recent examination after six years of service indicates that the concrete lining is still intact and is not cracked or checked in any way. It has stood up under the corrosive conditions as well as the temperature changes and mechanical stress caused by numerous changes of oxide in the box.

We can recommend this method of purifier repair as a very satisfactory scheme and one which will conserve the use of steel.



Gross Charge for Collecting Overdue Bills Upheld By Alabama Utility President

by

Special Correspondent

The current system of applying the costs for collecting overdue gas bills in gross charges on such customer's bills is fair and should continue, President Joseph N. Greene of the Alabama Gas Company told officials of a Public Service Commission at a special hearing in Montgomery, Alabama, March 23.

Mr. Greene is president of the above gas utility, Alabama Natural Gas Corporation and Huntsville Gas Company, all three of which were represented at the commission's hearing. The meeting closely followed a similar investigation into rates and charges of electrical power companies in the same area.

In addition to Mr. Greene, the three utilities were represented by C. Van Den Berg, Jr., chairman of the board of directors for all three concerns, and Raymond Beeny, secretary-treasurer. Acting as a special committee, the three executives have toured all holdings in a special rate survey preceding the meeting.

Replying to a question from the commission as to whether it would be possible to discontinue the delinquent bill gross charge, Mr. Greene replied that he could not determine the exact effect of eliminating such a charge. He pointed out that its abolishment would penalize prompt-paying customers who then would be forced to absorb this cost in their regular bills. The gross charge, he added, covers only the cost of collecting delinquent bills.

His suggestions included the outlining of two basic theories of discounts which were first, a gross charge over a net bill on delinquent accounts makes for quicker payment of bills, and secondly, the gross charge to such customers covers the cost of collecting the bill to prevent any strain on the current rate structure. "It is entirely possible but not probable that there would be a complete reduction in the number of delinquent customers with whom our companies deal if the discount should be eliminated," Mr. Greene said. He pointed out however, that in view of war time restrictions and the shortage of manpower, it was no time to take any action which would necessitate increased consumption of gasoline and tire rubber.

Mr. Greene summed up by stating that he thought it was in all ways fair and equitable to have the delinquent customer pay the cost of collections rather than to spread it through the whole rate structure so that all customers shared equally in absorbing the expense.

Refunds of Earnings

In an order described as an innovation in the field of public utility rate regulation, the Arkansas Utilities Commission has established as its wartime policy a program of ordering annual refunds of excess earnings to customers by private utility companies.

Although members of the commission declined to elaborate, the action was regarded as affording the utilities a means of building consumer good-will and reducing the amount of excess profits taxes to be paid to the Federal Government.

The general order was a development of a special agreement in December under which the Arkansas Power and Light Company refunded $625,000 to its customers on their 1942 bills. P. A. Lasley, special counsel, said it also developed from agreements reached in 1935 with two small water companies for rebates to consumers on a fixed scale whenever earnings exceeded certain amounts.

FIRING AWAY

More production is the order of the day. Men and machines work on, while guns, tanks, ships, planes, ammunition become the tools of war. This is a vital part of our Nation's program for Victory. It enables our armed forces to thunder their powerful message to the enemy on the world's fighting fronts. Behind this mighty task, providing boundless, unfailing energy for our industries, are Natural Gas and Electricity—master servants which perform their appointed wartime duties silently, effectively, continuously . .

★
1500

Yes, Columbia System is enlisted for the duration. Already 1500 of its employees have relinquished varied peacetime duties to join the colors.

COLUMBIA GAS & ELECTRIC
CORPORATION

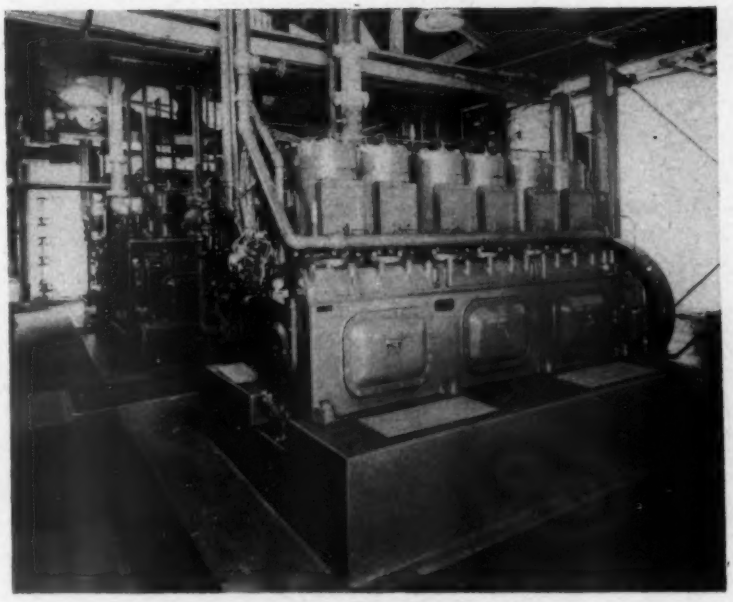
Natural Gas Power for Creamery Refrigeration Cuts Operating Costs by 50%

by

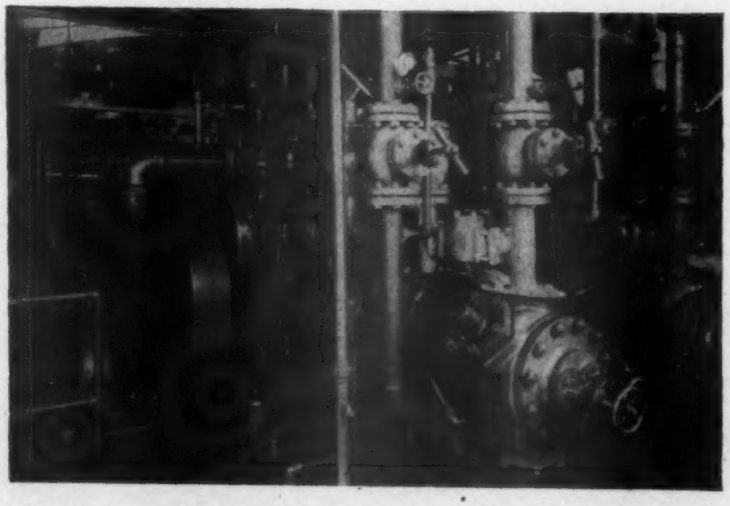
James Kearns

WAR TIME operation of creamery refrigeration has become a doubly difficult task with parts shortages, restrictions on new equipment, and unavailability of control devices—therefore the exacting job of maintaining proper refrigeration must combine an ample source of power with rugged efficiency and precise control at all times. Because milk, ice cream and other dairy products are extremely perishable, but needed more than ever during the war period, natural gas power has shown itself ideal in many of the nation's leading plants.

Typical of large-scale creameries now using natural gas fuel with angle-type gas engine compressors is the Knudsen Creamery of Los Angeles, supplying many hospitals, defense plants, Army and Navy posts with its dairy products. This firm, operating more than 50 refrigerated trucks and huge network of delivery routes, is now powered throughout with three Worthington angle gas engine compressors consisting of vertical gas engines and horizontal compressors built integral as one unit. These are rare in creamery plants, where standard practice has been to install the compressors as separate units driven through gear trains or V-belts. The angle type was chosen by the Los Angeles creamery because of the high efficiency of the multiple-cylinder built in design and a scarcity of engine room space for a larger installation.



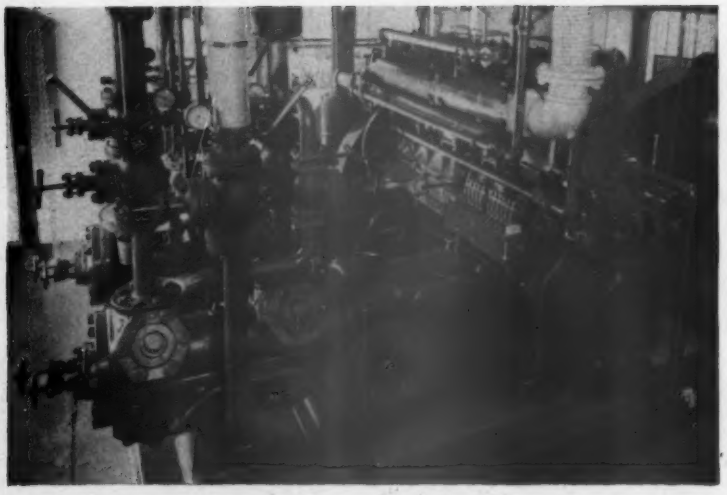
Six cylinder Worthington Unit. This maintains the ratio of two power pistons to one compressor unit.



One of the two 150 H.P. natural gas units. No. 1, in the foreground, generates both electricity and refrigeration, No. 2 is for refrigeration only.

Two of the gas units are of 150 HP., used in conjunction.

The first engine, though it was designed to utilize two cylinders, mounts only one, which is a double acting type rated 44 tons at a 25-pound suction and 175 pounds head pressure. The gas engine supplies also power for a Westinghouse 60 horsepower generator supplying illumination and utility current for the entire plant. Regulation of the unit with this extra load is provided by a constant speed governor, removable



No. 2 unit, showing two horizontal 44-ton ammonia-compressor cylinders working directly off engine crankshaft.

should it become necessary to apply the second cylinder for additional refrigeration tonnage.

Mounted alongside of this unit is the second, which is likewise directly powered through the engine crankshaft. There are two cylinders of different sizes, one 8 x 12, the other 9 x 12 inches, so that in cooperation with the first unit, variant pressures of 15, 25 and 40 pounds can be supplied at the same time. The connection is made through headers on all three cylinders. There is a power-take-off making it possible for the second unit to take over the generator load when the first is out of service. Belt shifting alone is necessary to make this change efficiently.

The third unit is much more powerful with six cylinders, but also maintains the ratio of two power pistons to one compressor unit. They are also double acting, providing 185 tons refrigeration of the 340 daily ton requirement in the Knudsen plant (at peak). Approximately 225 tons is the demand refrigeration, and as can be seen there is ample expansion capacity without installation of new equipment now difficult to obtain.

As outlined before the combination-operating facilities of the natural-gas powered engines make it possible to provide any type of tonnage. Forty pounds are required to hold milk at 32 degrees, 25 for the large brine tank and cold storage rooms, fifteen pounds for the delivery trucks and for making chip ice. Around 400,000 pounds are provided daily. A 35,000 gallon brine tank with 7000 feet of 1¼ inch pipe is one of the largest users.

Power for the large delivery fleet is provided by the second unit, using a single compressor cylinder connected to the hook-on stations at the loading platform. Truck connections are made by holdover plates, or "cold hold" dome type freezing units, valves and couplings. Truck bodies are kapok insulated, and doors have been cut down to permit less loss on delivery stops. The ton and a half models contain an ammonia evaporating device and freeze a brine paste at 18 degrees Fahrenheit with a capacity of 13,000 BTU.'s per plate. Truck temperatures are held at 35 to 40 degrees with a loss of less than 6 degrees through an operating day.

Natural gas supplied for the compressor units required no enlargement of existing lines, and has shown a substantial decrease in operating costs, amounting to 50%. Formerly, purchased power cost approximately $42 per day for 67 tons of plant refrigeration, or one cent per kilowatt hour. The present cost is six mills per kilowatt hour, with a consumption of 100,000 feet of 1,050 BTU gas per twenty-four hours for 225 tons of refrigeration. With allowance for fluctuations in gas use, the average monthly consumption was around 2,632,500 cubic feet at a trifle less than twenty cents per thousand cubic feet. Carrying the generating load and other responsibilities, the cost per ton with natural gas has been the same as for a kilowatt hour of energy, or six mills per ton of refrigeration—amounting to half the former power cost.

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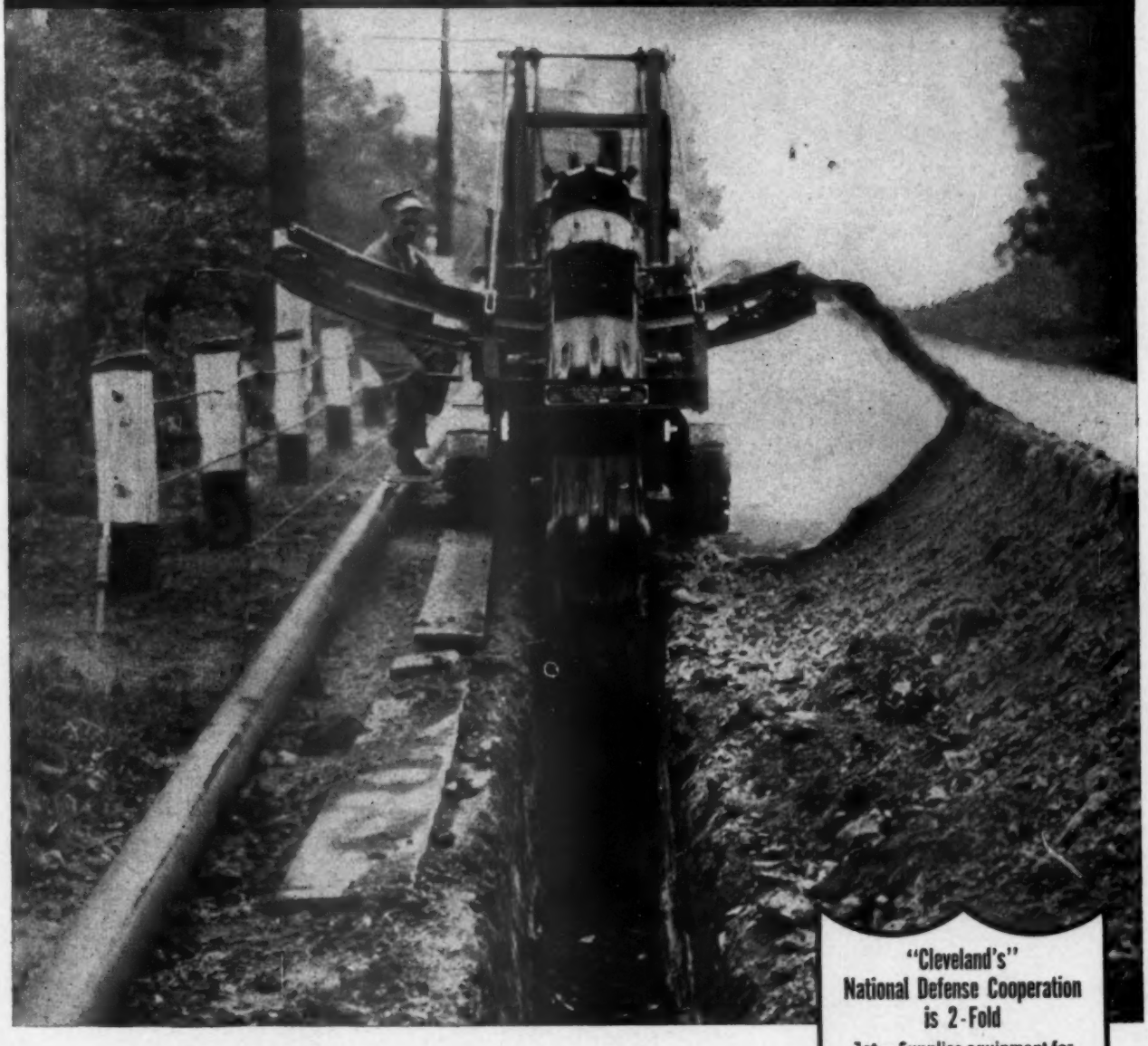

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BLAW-KNOX GAS CLEANERS

Unique Underground Storage Reservoir Solves Acute Gas Shortage Problem In Los Angeles

By
Lucius S. Flint

THE DANGER of a serious gas shortage in war-vital Southern California is being minimized through a unique underground storage project which will provide on the home grounds an estimated capacity of nearly 2 billion cu. ft.

The Southern California Gas Co., which serves most of the vast Los Angeles area, was put in a difficult spot by the advent of war. Unlike the earlier period of mushroom growth in Los Angeles, the population increase here in recent years had been only gradual. Thus, gas handling and storage facilities had been increased slowly—only in proportion to normal growth.

As the aircraft plants began rolling on lend lease orders, there was a marked increase—both in population and in industrial consumption. But this wasn't so rapid but what the company could fairly well keep pace. Materials for expansion of facilities were still available.

With Pearl Harbor, the situation was suddenly changed. Overnight, the airplane factories swung into high gear. Overnight, vast numbers of new plants—many of them small but nearly all gas users—came into being. And overnight a wave of migration to the West Coast community was felt. In a single year, the population of Los Angeles County increased an estimated 500,000.

The worst of it all was that steel and other materials necessary for expansion were suddenly tied up. Neither additional pipelines nor holders could be added.

Just what would happen depended a lot on the weather man. If he was gentle, there was a chance of getting through. And, on the whole, quite fortunately, he was gentle. But that luck was too good to be depended on.

The seriousness of the problem had become evident as early as the fall of 1941. The industrial load was beginning to hit heavily at that time. And, there was cold weather brewing. Despite the rapid expansion of facilities then under way, the company wasn't able to quite keep up. Thus, during one brief cold snap, a few industrial users had to be cut off temporarily—this was provided for by contract—to prevent suffering in the homes of consumers.

It was that incident which indirectly brought much needed aid to the company. Producers of lend-lease materials complained to the government. The Railroad Commission, which regulates all California utilities, began a study of the possibilities in underground storage.

Thus, the groundwork was laid. After Pearl Harbor of course the industrial load became a matter of vital government concern and as a result, hurdles which would normally be impossible to clear were swept away. Some relief is already being provided. And, by the winter of 1943-44, the gas shortage hazard here will have been eliminated entirely.

Storage Site Formerly An Oil Field

Underground storage of gas isn't a new idea. But its application in this situation could have never been worked out except for the war. The Playa Del Rey field, located in a beach area near Los Angeles, had long been recognized as a probably ideal storage reservoir. However, it was still producing some oil. Furthermore, ownership of the field was so split up—among more than 200 interests — that it would have been impossible for any private agency to acquire the necessary rights for usage. Even the state had no authority to condemn the field. But this, the Federal Government did with a single directive.

That was the real accomplishment in the whole project. Once that ownership problem was solved, the technical details were easily worked out.

Actually, owners of the property will probably be better off than if the field had remained in production. The field was discovered in 1931. By 1935, it had reached a peak of 14,000 barrels a day. By 1937, production was down to 3,000 barrels. At the time production ceased, only 17 wells were pumping—producing but 750 barrels a day.

With the total life of the field estimated at 50 million barrels and the cost of 304 wells and 85 dry holes figured in, the actual value of the field today was nil, the oil experts say. Most of the owners were selling nothing more than dry holes anyway.

Huge Sponge Of Exhausted Oil Sands

Of course before the deal was completed, original estimates of the value of the field as a gas storage site had to be confirmed. The Railroad Commission first investigated drillers' logs, electric logs and core records furnished by the Union Oil Co. which owns about 50 per cent of the wells in the field. Contour maps were then made of the top of the producing zone and of the underlying schist. Thus, it was possible to determine the thickness of the sand above the water table and to construct an isopatch map of the sand thickness for the entire area.

It was found that the sands averaged 85 feet in thickness and covered an area of about 310 acres. Considering the formations involved, sand porosity and other factors, engineers calculated the practical storage capacity of the 20,428 acre feet of sand at about 2 billion cubic feet. The actual capacity is probably about 50 per cent greater than this figure but above 2 billion cu. ft., conditions of pressure required would be impractical.

However, if the 2 billion cu. ft. estimate proves accurate, storage capacity in proximity to point of usage will have been raised to a point where the danger of shortage should be practically eliminated. Storage has

now begun on a small scale and by next fall, capacity will have been definitely established.

A special study by the Railroad Commission showed the normal supply of gas to the Los Angeles-San Diego area to be about 528 million cu. ft. per 24 hours. The estimated noncurtailable peak demand for a like period is 600 million cu. ft. This figure does not include a 145 million cu. ft. industrial load.

Thus, prior to development of the underground storage project, there was a potential deficiency of 78 million cu. ft. exclusive of the industrial demand which under present conditions is an absolutely vital load. Of course some of the plants which create the latter demand have standby equipment but because of war-time restrictions many were unable to get such equipment. In any event, an additional storage capacity of 2 billion cu. ft. should provide an ample margin of safety.

Incidentally, it might be explained that because of extreme fluctuations in temperature here, there are at times what would seem abnormal loads for a mild climate area of this population. Winter brings alternating warm and cold days. At several times in recent years, freezing temperatures have been widely recorded.

All of this means a need for extremely heavy storage facilities. The fields from which the bulk of the supply is received are distant—located mostly in the San Joaquin Valley. Before the war brought industrial expansion, an increase in population and government restrictions on oil well operation, the pipeline capacity was adequate for meeting the peaks—and what summer wastage there was at the wells was unimportant. Now, however, all this is changed.

Although wastage has been practically eliminated by returning unused gas to the wells during the summer slack period, there was still a summer loss in unused pipeline capacity. Gas had to be kept at the fields—for lack of storage facilities at point of usage—which should have been used to create a winter reserve. The Playa Del Rey project will correct this condition, also providing storage for by-product gas which will be produced by a new butadiene plant.

Even in normal times, the underground storage reservoir will be of tremendous value from a cost saving standpoint. Gas can be stored here for a fraction of the cost involved in construction and maintenance of additional holders. A final advantage is the fact that a tremendous reserve will be underground where it's completely safe from possible enemy raids.

Equipment Required

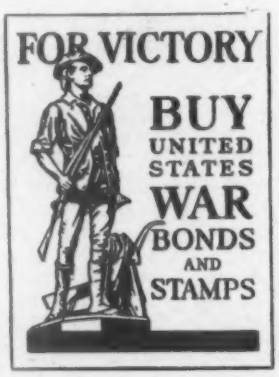
Though a relatively small amount of equipment was required to put the project into operation, the lack of supplies made it necessary to turn to salvage operations to provide much of it. The company was able to obtain new most of the 26 in. pipe required for the 3.5 mile long main trunk line from which the gas is taken for storage. Used pipe reconditioned in a Southern Calif. Gas Co., plant had to be used very largely for the 18,000 ft. line of 12¾" size from the trunk to the compressors. Distribution and collection lines were also very largely of reclaimed materials. Since these various lines would eventually have to carry pressures up to 1,000 pounds per sq. in., extreme care in selection and conditioning was required.

The gas is injected through wells—former oil producers. Simple wellhead connections are used, gas being forced downward through either the tubing or between the tubing and the casing.

At the outset, gas was injected without compression, a considerable amount being put into the sand before an increase in line pressure was required. However, a compression plant has now been installed and test pressures up to 450 pounds per sq. in., have been applied.

The compressors in use—eight of 200 h. p. size and one 160 pound auxiliary unit—were idle ones removed from a company plant in the San Joaquin Valley. As used now, this equipment will provide a maximum of only 500 pounds per sq. in. pressure so additions will be necessary.

It is estimated that to utilize the 2 billion cu. ft. capacity with a 1 billion cu. ft. backlog, it will be necessary to use an injection pressure of 1,000 pounds per sq. in. The present plan is to use two-stage compression. In the first stage, gas will be raised from a line pressure of 150 pounds to 450 pounds. The second stage would be capable of a boost to 1500 pounds. This latter stage will be achieved by equipping part of the compressors with high pressure cylinders.



Removal of Hydrogen Sulphide

The final problem is that of decontaminating the gas as it is withdrawn from the underground storage reservoir. Natural gas from the fields which serve this area contains up to 7 grains of hydrogen sulphide per 100 cu. ft., enough to damage equipment. Though the actual amount remains to be tested, it is assumed that during storage underground, the sulphur-free gas may absorb about an equal amount. Materials for construction of a decontamination plant have been obtained—again quite largely by salvage—and this equipment is now being set up.

The Southern California Gas Co., laid the necessary pipelines and also installed and operates other equipment required by the project. Duties other than those directly affecting installation and operation are handled by the Union Oil Co., as an agent for the Defense Plant Corp. The gas company pays for use of the reservoir and compensates owners for discontinuance of oil production—on a 3½ cent per thousand cu. ft. as gas is withdrawn. All cost factors were taken into account in this figure.

Because of a rather cold winter this year and a constantly increasing industrial load, there has been relatively little surplus for injection into the field to date. By summer, however, a sizeable surplus is expected to be available. Instead of being held at the fields, that surplus will be stored where it's needed—ready for instant use.

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◆

The Operation of Limitation Order L-31 In The Ordnance Department

By
Lt. Col. R. B. Harris
Chief, Fuel & Power Unit
Detroit Ordnance District

At the A.G.A. Industrial and Commercial Gas Section meeting at Detroit, March 11 and 12, Lt. Col. R. B. Harris, Chief, Fuel & Power Unit, Detroit Ordnance District, explained the operation of Limitation Order L-31, and at the conclusion of his remarks, introduced Brig. Gen. Walter B. Pyron, Chief, Fuels Branch, Services of Supply, Washington, D. C. Abstracts of both papers are presented here—Editor.

THE ORDNANCE DEPARTMENT is charged with the responsibility of procuring, inspecting and maintaining all combat material for the Army and, consequently, have in force contracts totaling many billions of dollars. These contracts are for tanks, vehicles, guns, ammunition, and a multitude of accessory equipment. The continuous flow of this material to the combat areas is as important as its design and maintenance and the supply of fuels and power to the producers is necessary if this flow is to continue.

As an added precaution toward maintaining uninterrupted production of ordnance facilities, the Fuels and Power Section of the Ordnance Department was created. It has the responsibility of coordinating and controlling fuel and power supplies to ordnance facilities.

The Fuels and Power Section is authorized to deal with the War Production Board and other government agencies through proper channels and to cooperate with and assist these agencies, public utilities and war industries in matters relating to fuels and power supply.

It is responsible for all surveys, investigations and other information as are necessary for the proper control of fuels to ordnance facilities. It recommends the desired action necessary for such control to interested government agencies and responsible authorities. It assists ordnance facilities in securing and maintaining adequate supplies and sources of fuels for the maintenance of uninterrupted production. Lastly, it may direct ordnance facilities when necessary and advisable, to effect fuel conversion and to install standby equipment so that maximum operative utilization of available supplies of fuels may be obtained.

Specifically, with reference to Limitation Order L-31, this section encourages industries to convert existing gas burners to substitute fuels, and those now using gas, to install standby equipment for the use of substitute fuels during critical periods. It makes recommendations to the War Production Board as to the necessity of installing new gas burners in new or expanded industries. It encourages users of gas for space heating purposes to convert their equipment to substitute fuels.

The gas industry has cooperated very splendidly with the program. In fact, the various units have been staffed for the most part with engineers loaned to the Ordnance Department for the duration of the war. The Technical Staff of the Detroit Unit consists of three men from the Michigan Consolidated Gas Company and one from Consumers Power Company. This has resulted in an intelligent approach to the fuel problems and has built up confidence among contractors and suppliers.

The oil situation has become very critical and it is the opinion of the War Production Board and the Office of the Petroleum Administration for War that the available oil supplies should be reserved for those operations where less critical fuels are not suitable. Consequently, a concerted effort, in which the Ordnance Department concurs, is being made to convert space heating, water heating and steam generation from oil wherever feasible. In this program consideration must be given to the amounts of critical material necessary for such conversion. In some cases, conversion to natural gas can be made easily and economically.

The question of standby for natural gas of various fuels has engaged the attention of all of those concerned with the continuity of production. It may be said that insofar as the Detroit Ordnance District is concerned, natural gas supplies are at present adequate, except during periods of severe weather. For some metallurgical operations, oil is not a suitable standby. The installation of liquefied petroleum gas necessitates the utilization of equipment which requires the use of a large amount of critical material. For these reasons, the installation of standby equipment is not always justified, particularly if production lost through a curtailment of gas supplies can be made up by subsequent intensified operations or if a bank of material can be maintained. When shortages of natural gas supplies occur, the Limitation Order as amended outlines a satisfactory procedure. Interruptible customers are first curtailed; and it is, therefore, essential that these consumers maintain adequate standby if they are engaged in essential war work.

The War Department Liaison Officer for Petroleum is Brigadier General Walter B. Pyron. In September, 1941 he went to Washington, D. C. for duty in the office of the under Secretary of War and in March, 1942 he became Liaison Officer for Petroleum in the Resources Division at the Headquarters of the Services of Supply. In civil life General Pyron was Executive Vice President of the Gulf Oil Refining Company.

Supply of Gas to War Industries

By
Brig. Gen. Walter B. Pyron

WHEN the United States entered the second World War, 95% of the petroleum and petroleum products refined and used on the Atlantic Coast were transported to the Atlantic Coast by tanker, from the Gulf of Mexico area and Caribbean area.

In the early part of 1942, enemy submarines started an active campaign on the East Coast, Gulf Coast, and in the Caribbean. Early in the summer of 1942, it was necessary to transfer a large number of tankers to overseas service; both in the Atlantic and Pacific. This new movement was necessary to supply petroleum products to Allied nations as well as our own overseas forces. As a result of the enemy submarine campaign and the diversion of tankers to overseas service, the tanker movements to the East Coast from the Gulf of Mexico and Caribbean areas have been reduced to a very small figure.

Due to the lack of crude oil supply in the Atlantic states, it is necessary here to transport a substantial amount of crude oil to the East Coast to be used by eastern refineries in manufacturing aviation gasoline, toluene, butadiene, as well as other petroleum products. To meet the deficiency caused by the loss of tanker tonnage, the petroleum industry, Petroleum Administration for War, Defense Transportation, and War Production Board embarked upon a program of moving oil by tank car and barges. The movement by tank car has been phenomenal.

New Supply Lines

The Petroleum Administrator for War arranged for the reversal of pipelines that had previously moved petroleum products from the East Coast to the Appalachian area, and even further west. P.A.W. and other Governmental agencies arranged for the construction of a 24-inch crude oil line, from Texas to the East Coast. This line has been completed to Illinois, a mid-way point, and will have been completed to the East Coast by June, 1943. A 20-inch petroleum products line has been authorized, and will be constructed from Texas and Louisiana, to a point in Indiana where the products will be loaded on tank cars for shipment to various East Coast points. When this line is completed, it will have the effect of materially increasing the amount of petroleum products reaching the East Coast, due to a shorter tank car turn-around time from Indiana, as compared to movements from Texas and Louisiana.

The Plantation pipeline, designed for moving petroleum products from Baton Rouge to a point in North Carolina, has been extended southwest, to the Houston, Texas, refining area, and is being extended, on the northeast, to a point near Norfolk, Virginia. Pumping capacity has been added, which will result in this line having a total carrying capacity of 90,000 barrels per day.

An 8-inch products line has been laid across Florida, which will receive oil from barge movements, from Texas-Louisiana points, and will transfer it to barges and tank cars on the east side of Florida for distribution by coastal canals to the southeastern part of the United States. Additional barge lines have been, and are being implemented for use on the Mississippi River, Ohio River, Gulf Coast and Atlantic Coast canals.

The completion of all facilities above enumerated will greatly relieve the East Coast situation but will not entirely meet the demand for offshore shipments and essential demands for utilities and civilians on the East Coast. It is vital to the war effort that the maximum amount of natural gas, fuel oil and gasoline be made available to the East Coast. In addition to the increasing offshore demands, many of the largest war production plants are located in the general East Coast area. Fuel on an uninterruptible basis must be furnished these plants as well as the utilities serving the war effort. Adequate fuel must be furnished to essential civilian agencies as well as domestic consumers.

Civilian Requirements

To meet the necessary demands from war production plants, we must provide sufficient supplies of fuel to the civilian population to assure proper health and efficiency of those engaged in war work and essential industries. This is absolutely vital to the war effort, as a break-down in the health and efficiency of war workers would interfere greatly in the war plans.

We have struggled through a very bad winter season, by the proverbial "skin of our teeth." Many emergency measures have been taken, not necessary to enumerate here, but I can say to you that there has not been a serious shut-down in any war plant or utility, nor has there been any undue suffering of civilian population.

Stocks of fuel and heating oil especially have been reduced to a dangerous level, and must be built up during the summer months to meet the heavy demands of the coming winter season. *This can, and must be done but it will require the closest cooperation of all agencies concerned with fuel of all classes, and will require the continued sacrifice on the part of the civilian population.*

The gas industry has cooperated whole-heartedly in this critical problem and deserves commendation for its prompt and effective efforts in supplying war plants, utilities, and essential industries.

While the East Coast situation is the most critical one, at the moment, *let me impress upon you that the fuel problem is nationwide in scope, and must be approached and solved from that standpoint.*

Your estimate of gas requirements no doubt indicates to you that additional wells should be drilled, additional transmission lines laid and various improvements made in your facilities. Let me warn you that the need for steel and steel products for essential military requirements is still so great that the War Production Board and other agencies having to do with the allocation of these critical materials will subject your requirements to a very close screening. The War Production Board is struggling with the Herculean task of distributing all critical materials to the agencies and usages that will best serve the war effort. I am sure that agency will have your wholehearted cooperation in these matters.

It is believed a number of things can be done by the gas industry to alleviate existing conditions, foremost among which are:

a. Converting plants using fuel oil to the use of gas, during the summer months; thereby permitting a build-up of oil and coal stocks prior to the winter season.

b. Make the maximum use of all existing facilities for fuel handling and burning equipment

(Continued on page 49)

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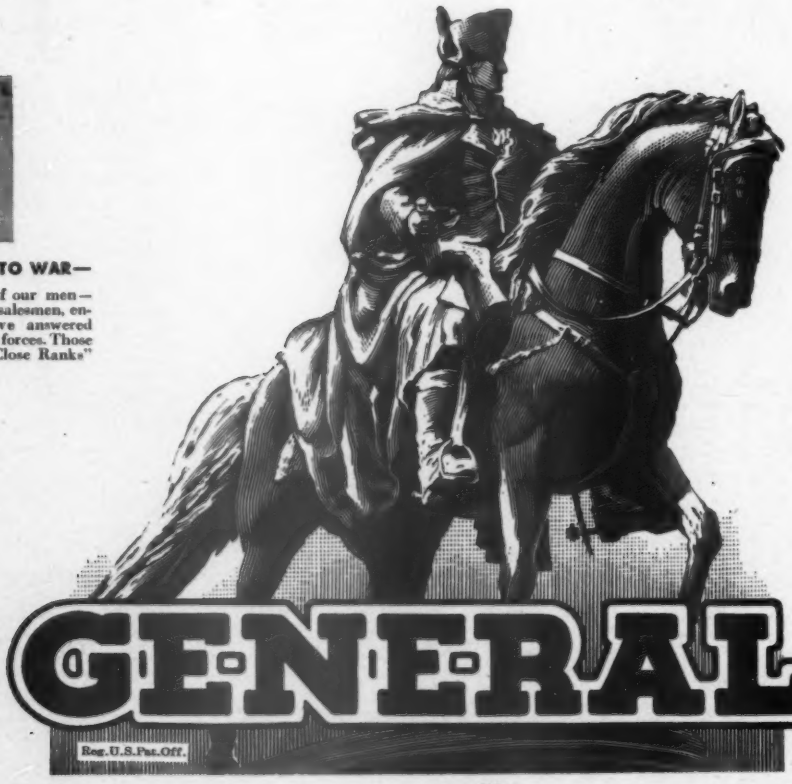

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RECENT COURT DECISIONS
Affecting Gas Utilities

Validity of Delegated Powers

by
Leo T. Parker

Attorney at Law
Cincinnati, Ohio

CONSIDERABLE discussion has arisen from time to time over the legal question: When, and under what circumstance, and to what extent, may a State Legislature delegate valid power and authority to officials and commissions, particularly with respect to conservation of gas?

The validity of laws formulated to conserve gas is well established. Generally, such laws basicly arise from the legislature, but usually they must be enforced and worked out in detail by officials or commissions having delegated power.

Before entering into this discussion it is well to realize that a State Legislature has no time, opportunity nor inclination to attend to many and numerous details. Therefore, state laws which delegate ordinary power and authority are valid providing such laws do not give to such officials and commissions powers of the courts.

Due to present unnatural and emergency war conditions considerable attention is being given to eliminate waste of gas resulting from excessive or improper use or dissipation of the gas in a common pool. Modern higher courts have taken the view that this waste will occur if numerous wells are drilled in a small area. In general it is because a large amount of gas is consumed as fuel in the drilling of new wells; because other large amounts of gas are used when these new wells are permitted to "clean themselves out," and besides, it is said that these wells are usually abandoned at a higher bottom hole pressure than when they are well spaced. Another reason is that when wells are spaced too close together there is an increased danger of "blow outs."

It is not possible for the state itself to be present at each time the open flow capacity of a well is tested, in order to ascertain whether the percentage of the gas to be taken should be increased or decreased, according to the conditions of the well or its production. Should the state attempt to exercise such authority, the whole time of the Legislature would be thus consumed; its acts would be endless; and the thing would be utterly impracticable. Such reasons are given for apparent broad authority of commissions.

A latest decision on this subject is State v. Housing Authority, 182 So. 725, where the court quoted:

"The authority of the Legislature to delegate to the administrative boards and agencies of the state the power and authority of ascertaining and determining the facts upon which the laws are to be applied and enforced cannot be seriously disputed."

Authority to Conserve

It is well known that the drilling of more wells than are necessary to drain a gas field efficiently and economically causes "waste," as previously explained.

Obviously, whether laws and regulations are valid which are intended to prevent this waste depends upon the particular circumstances of each case. Therefore, we shall review in detail several interesting higher court cases on this phase of law, and particularly the last Hunter case.

For example, in Hunter Company v. McHugh, 11 So. (2d) 495, reported January, 1943, it was shown that a state passed a law for the prevention of waste and to avoid the drilling of unnecessary gas wells. The law authorized a Commissioner to establish a drilling unit or units for each pool. A drilling unit, as contemplated by the law, meant the maximum area which may be efficiently and economically drained by one well.

The Hunter Company drilled the first well to produce gas in a 25,000 acre field. The well is on a 190-acre lease and was completed on June 1 1938, costing approximately $44,000. Thereafter the company constructed its own pipe line, at a cost of $12,-380.16, to a line owned by the United Gas Pipe Line Company, and commenced delivering gas to that company. Meanwhile another Production Company had acquired extensive leases in the field and drilled several producing gas wells, from which the company transported gas through its own pipe line to industrial and domestic markets.

The Commission established a rule which required that the locations of the wells in the field should be approximately in the center of each 320-acre drilling unit. The rule conflicted with the Hunter Company's plans for drilling wells on its 190-acre tract. The contention of the Hunter Company was that the restriction on production from its wells on the 190-acre lease, the allowable being measured according to the provisions of section 3 of Act No. 252 requiring the company to pool or unitize the 190-acre lease with sufficient acreage to conform with the 320-acre unit, was unconstitutional.

The Hunter Company contended that this state law was void for two reasons, namely: (1) The State Legislature attempted to delegate to the Commissioner of Conservation the legislative power to adopt rules and regulations pertaining to drilling units, without a definite pattern or plan being first adopted and established by the Legislature. (2) By attempting to authorize the Commissioner to compel the pooling of the interests of two or more landowners or leaseholders into a drilling unit the law attempted to deprive the landowner or leaseholder of his property without due process of law, especially where he had drilled a producing well and had established a market for the gas being produced from the well.

The higher court held the first rea-

son of no effect because the State Constitution places the conservation of the natural resources of the state under the control of a Commission or Commissioner, and virtually directs the Legislature to invest the Commissioner with authority to establish rules and regulations for the conservation of the natural resources of the state. The Constitution provides: "The natural resources of the state shall be protected, conserved and replenished; and for that purpose shall be placed under a Department of Conservation, which is hereby created and established. The Department of Conservation shall be directed and controlled by a Commissioner of Conservation to be appointed as elsewhere provided in this constitution, who shall have and exercise such authority and power as may be prescribed by law. The Legislature shall enact all laws necessary to protect, conserve and replenish the natural resources of the state, and to prohibit and prevent the waste or any wasteful use thereof."

Therefore, in holding the Commission properly authorized to require that the location of wells must be in the center of 320-acre tracts, the court said:

"This declaration, that the Commissioner of Conservation 'shall have and exercise such authority and power as may be prescribed by law' for the conservation of the natural resources, which he shall direct and control, must prevail over any general objection to the delegation of rule-making powers to a fact-finding Commission or Commissioner."

Also, see State v. Guidry, 142 La. 422, 76 So. 843, which related to a state law authorizing a Commission to conserve gas.

The ground on which the constitutionality of the statute was questioned was that it attempted to delegate legislative authority to the conservation commission.

This court held that the authority of the Legislature to delegate to administrative boards and agencies of the state the power and authority of ascertaining and determining the facts upon which the laws are to be applied and enforced could not be seriously disputed.

And, again see State v. Carson Carbon Company, 111 So. 162, with regard to a law regulating and limiting the use of natural gas in the manufacture of carbon black. This state law authorized, directed, and empowered the Commissioner of Conservation to fix and determine "what percentage of consumption of natural gas produced by each gas well" may be used in the manufacture of carbon black.

In holding the law valid the court said:

"The Constitution requires that the Legislature shall enact all laws necessary to protect, conserve, and replenish the natural resources of the state and to prohibit and prevent the waste or any wasteful use thereof."

And in a leading case, Bandini Company v. Superior Court, 293 Pac. 899, the court upheld the validity of a state law which generally provided against unreasonable waste of natural gas. This court said:

"It is well known that the supply of gas in limited, and may be exhausted. The act is intended to protect the supply from waste. Under the act, it is conceded, a person, to exhaust the supply of his neighbor, cannot put down wells on his own land, and allow the gas to escape at the well. . . . The Legislature may protect from waste the natural resources of the state, which are the common heritage of all. The right of the owner of property to do with it as he pleases is subject to the limitation that he must have due regard for the rights of others."

Not Judicial Power

Frequently, the validity of a law of this nature is attacked on the grounds

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that by authorizing State Officials, or Commissions, to settle disputes the natural judicial power of the courts is violated. However, this argument is not sound.

For example, in the case of State Porterie, Attorney General, v. Grace, 166 So. 133, a citizen sued to annul certain agreements made by the Register of the State Land Office with the holder of certain mineral leases under the provisions of a state law.

The attorney general contended that the statute was unconstitutional because it was an attempt to confer legislative and judicial powers upon the register of the state land office, and upon the Governor, to settle by agreement with the holders of mineral leases from the state all questions or controversies arising over the interpretation of such leases and the performances of the covenants, conditions, obligations and stipulations thereof. In affirming the constitutionality of the law, the court said:

"In the very nature of things, the officers who are vested with the authority to make contracts of lease as the agents of the state and to exercise some discretion in fixing the terms and conditions of such contracts ought to have the authority and the necessary discretion to determine whether the terms tnd conditions of the contracts are complied with. The exercise of such authority is only an administrative function, and does not form part of the 'judicial power' referred to in the Constitution as being vested in the courts."

Therefore, it seems that the higher courts are in accord with the principle of law that a state law is valid which provides that the courts will not place their judgment above that of the executive or administrative officers who are designated by state laws as the agents of the state in the determination of matters peculiarly within the knowledge of such officers.

This does not mean that the officers so designated are invested with "judicial power" in the sense in which that power is exercised by the courts. See Conery, 7 So. 8; Holmes, 22 So. 403; Edison Electric Company v. City, 58 So. 512; and State v. Guidry, 76 So. 843. In the latter case the court said that the right of the State Legislature to delegate to an administrative board or agency the authority to determine the facts upon which the law is to be applied is beyond dispute.

Therefore, according to modern courts a statute which delegates to an administrative officer or board or Commission the authority to find the facts upon which the law is to be applied is not a delegation of either the judicial or the legislative power.

United States Supreme Court Review

It is interesting to review the decisions rendered by the United States Supreme Court with respect to how far State Legislatures may go when delegating authority to officials and Commissions. While these particular cases are not directly connected with the gas industry, yet they are *basic* decisions upon which modern higher courts are dependent.

In one case, Union Bridge Company v. United States, 204 U. S. 364, the United States Supreme Court applied the doctrine thus:

"Legislative and judicial powers are not unconstitutionally delegated to the Secretary of War by the provision of the river and harbor act empowered that official, when satisfied, after a hearing of the parties interested, that a bridge over a navigable waterway of the United States is an unreasonable obstruction to navigation, to require such changes or alterations as will render navigation reasonably safe, easy, and unobstructed."

In another United States Supreme Court case, Mutual Corporation v. Industrial Commission of Ohio, 236 U. S. 230, with respect to censors, who have broad delegate powers, the court said:

"Legislative power is not unlawfully delegated for the creation of a board of censors which is to examine and censor, as a condition precedent to exhibition, motion picture films which are to be publicly exhibited and displayed in the state, and is to pass and approve only such films as are, in its judgment, of a moral, educational, or amusing and harmless character."

In still another case, J. W. Hampton, Jr., & Company c. United States, 276 U. S. 394, the Supreme Court of the United States gave this illustration of the rule:

"If Congress shall lay down by legislative act an intelligent principle to which the person or body authorized to fix the rate of customs duties on imported merchandise is directed to conform, such legislative action is not a forbidden delegation or legislative power."

Tax Law Void

Frequently, state tax laws are necessary to produce sufficient revenue to enforce laws and regulations to conserve gas. However, the higher courts are exceedingly careful that such taxation laws do not interfere with interstate commerce laws.

Moreover, where the tax is exacted from a company doing both an interstate and intrastate business, the tax must be imposed solely on account of the intrastate business. Also, the amount exacted must not be increased because of the interstate business, because a company engaged exclusively in interstate commerce is not subject to state taxation.

For example, in State v. Montana-Dakota Utilities Company, 133 Pac. (2d) 354, reported February, 1943, it was disclosed that Montana state authorities sought to collect from the Montana-Dakota Utilities Company the sum of $5,379.18, which is the amount of the tax sought to be imposed by a state law upon the amount of gas conveyed during the first quarter of 1941 through its pipe lines to points *outside* the state of Montana. The Montana-Dakota Utilities Company refused to pay the tax and the state filed suit.

During the trial testimony was given to the effect that the state law required every company engaging in or carrying on the business of distributing natural gas within the state *or conducting natural gas* produced within this state through a pipe line to a point outside the state to pay to the State Treasurer a tax of one (1) cent for each one thousand (1000) cubic feet. Also, the law required payment of tax on "the business of distributing to the public within this state, natural gas, produced, or not produced within this state" or "owning, controlling, managing, leasing or operating within this state, any system or plant for" such public distribution.

The first is manifestly a license tax imposed on the business of engaging in certain interstate commerce, since it relates solely to the conveying of gas produced within the state for use outside of the state and, therefore, across state lines.

The second relates, not to the corresponding business of conveying gas in pipe lines for use within the state, but to the business of distributing natural gas to the public within the state.

It is interesting to observe that the higher court held the state not entitled to collect either tax, and said:

"A state cannot tax interstate commerce; it cannot lay a tax upon the business which constitutes such commerce or the privilege of engaging in it. And the fact that a portion of a business is intrastate and therefore taxable does not justify a tax either upon the interstate business or upon the whole business without discrimination."

Federal Power Commission Order in Hope Natural Gas Co. Case, Reversed

The United States Circuit Court of Appeals, Fourth Circuit, composed of Judges Parker, Soper and Dobie, rendered a decision February 16, 1943, reversing the Commission order in the case of The Hope Natural Gas Company, Petitioner, Versus Federal Power Commission, City of Cleveland, City of Akron and Pennsylvania Public Utility Commission, Respondents. The following is an abstract of the decision, written by Judge Parker.

"This is a petition by the Hope Natural Gas Company, hereinafter referred to as 'Hope,' to review an order of the Federal Power Commission under the provisions of sec. 19 (b) of the Natural Gas Act of June 21, 1938, 52 Stat. 831, 15 USCA 717 r (b). Hope, a subsidiary corporation of the Standard Oil Company of New Jersey, was organized under the laws of West Virginia in the year 1898 and since that time has been engaged in the production, transportation and sale of natural gas. 80% of its sales are in interstate commerce and are subject to the jurisdiction of the Commission, but its interstate rates had not been regulated prior to this proceeding. In 1938 the cities of Cleveland and Akron, Ohio, filed complaints with the Commission alleging that the rates charged by Hope to the East Ohio Gas Company were unreasonable. The Pennsylvania Public Utility Commission filed complaints that the rates charged to the Peoples Natural Gas Company, the Fayette Couny Gas Company and the Manufacturers Light and Heat Company were also unreasonable. The Commission then instituted an investigation, on its own motion, into the reasonableness of all of Hope's interstate wholesale rates; and all of the proceedings relating to these rates were consolidated for hearing before the Commission.

"On May 26, 1942, the Commission filed its opinion, findings and order holding that the rates charged since June 30, 1939 were unreasonable and establishing reduced rates for the future, the reduction ordered being approximately 20% in the rates charged the East Ohio Gas Company and the Peoples Natural Gas Company, both Standard Oil affiliates, to which by far the larger part of its sales were made. The rates to these companies were reduced from 36.5 and 35.5 cts. per m. c. f. to 29.5 and 28.5 cts. per m. c. f. respectively. Rates to two other companies, Fayette and Manufacturers, representing a small volume of the total sales, were reduced from 31.5 cts. to 28.5 cts.

"The reductions in rates were ordered on the basis of findings made as to the value of Hope's property used in connection with its interstate business, the estimated operating expenses of the business and a rate of return upon investment of 6½%. Hope complains of the findings with respect to all of these matters but particularly with respect to the valuation of the property adopted as the rate base. The valuation adopted by the Commission as the rate base was arrived at by taking the cost of the property as shown by the books of the company, corrected for bookkeeping errors but without allowance for price increases or consideration of capital items theretofore charged to expense, and deducting therefrom accrued depreciation based upon the estimated useful life of the property employed without reference to evidence as to its present condition based upon tests and observation. This method was applied to property taken over from other companies as well as to property originally purchased by Hope. The corrected book cost of the property was found to be $51,957,416, and depreciation was found to be $22,328,016 as of December 31, 1940, leaving a net investment of $29,629,400. To this was added $1,392,021 for net capital additions up until the effective date of the order, $566,105 for useful unoperated acreage and $2,125,000 for working capital. This gave a rate base of $33,712,526.

"Hope introduced evidence to the effect that prior to 1923 labor costs in well drilling as well as the portion of the overhead expense of the company allocable thereto had been treated as expense in its bookkeeping entries, instead of being charged to capital account; that these items were a legitimate part of the cost of the property and present expenditures of like character were required to be so treated in the system of accounting prescribed by the Commission; that the items representing such expenditures prior to 1923 should be considered by the Commisison as a part of the legitimate cost of the property notwithstanding they had been charged to expense; and that, when they were so considered, the cost of the property was shown to be $69,735,000, instead of $51,957,416.

"It was shown that the property used by Hope in its interstate business had been constructed over a forty year period during which there had been great fluctuations in prices and that prices at the time of hearing were at a far higher level than they were during the years preceding the first world war. The Public Utilities Commission of Ohio had found the reproduction cost new of the property, as of June 30, 1937, to be $100,257,000 and its present value after depreciation to be $66,166,382. Hope introduced an estimate of cost of reproduction new amounting to $97,340,000 and a statement showing that the application of price trends to original cost would result in a figure of $105,101,000. This price trend statement showed that for property placed in public service between 1891 and 1916 at an original cost of $25,249,550 the price trends gave a figure of $52,451,675, whereas for property placed in service between 1917 and 1938 at a cost of $45,303,889 the trended value was only $53,788,551. Hope contended that the allowance for depreciation should have been based on the actual condition of the property as determined by observation with allowance for obsolescence; and that the depreciation allowance resulting was 34.51%. Applying this rate of depreciation to the estimate of the cost of reproduction new of its property, it arrived at a rate base as of December 31, 1938, of $66,360,000.

"The Commission found that Hope's estimates of reproduction cost and trended original cost were without probative value and disregarded them as it did also Hope's evidence as to the observed condition of the property. No consideration was given to the change in price levels which was shown by the estimates and which, even in their absence, might have been noticed as matters of general and common knowledge.

"The vital questions in the case relate to the determination of the rate base; and, in view of the low rate of return allowed and the consequent lack of margin to take care of error in the base, the rates allowed must be condemned as unreasonable and confiscatory because of the following errors with respect to the valuation of the property constituting the base: (1) the Commission did not find the

present fair value of the property and took no account of the change of price levels in determining the rate base; (2) the Commission ignored items of well drilling costs and overhead, aggregating in excess of $17,000,000, which entered into the original cost of the property, basing this action on the fact that under the system of accounting that prevailed at the time, these items had been charged on the company's books to expense; and (3) the Commission ignored evidence as to the present condition of the property and computed accrued depreciation theoretically on the straight-line service-life method. We shall discuss these matters separately in the order named."

Here Judge Parker reviewed the various items entering into the case, covering Present Values, Exclusion of Well Drilling Costs, Depreciation, Operating Expenses, Rate of Return, Past Rates and Other Matters Affecting the Rate Case. Each item was thoroughly analyzed and previous decisions in similar cases quoted. His decision ended as follows.

"When rates were filed with the Commission pursuant to section 4 (c) of the Act they became the only lawful rates which the utility could charge or accept. Cf. *L. & N. R. Co.* v. *Maxwell* 237 U. S. 94. Until changed by the Commission under the power granted pursuant to section 5 (a) they were binding alike upon the company and its customers; and, in the absence of a provision for award of reparation, there could be no occasion for a determination of their reasonableness except as reason for changing them in an order prescribing rates for the future. The suggestion in the Commission's brief that exercise of power as to past rates is necessary to obviate injustices resulting from delay in rate proceedings lacks force in view of the provision of the statute for the entry of interim orders. Sec. 16. Cf. *Federal Power Com'n* v. *Natural Gas Pipeline Co.* 315 U. S. 575, 583.

"As a step in the process of fixing rates for the future, it was of course proper for the Commission to make findings with respect to the conditions and rates of the past, and we shall construe the findings as made pursuant to that power, and as subject to review like other findings made in support of the order. When so considered, they are invalidated by the same errors that vitiate the findings upon which the order fixing rates for the future is directly based.

"It is argued that we are without power to review the findings as to past rates because no order is based thereon; but, as stated above, they are reviewable because made as a step in the proceeding to fix rates for the future. If, however, they be considered separate and apart from this and it be thought, contrary to our view, that the Commission has power to make such findings as to past rates "as an aid to state regulation," we think, nevertheless, that there can be no question as to their being reviewable under the statute. Such determination in that case would be, in effect, an order of the Commission affecting substantial rights and contractual relationships of a party to a proceeding before it and would be reviewable as such, whatever it might be called. *Columbia Broadcasting System* v. *United States* 316 U. S. 407; *Rochester Telephone Corp.* v. *United States* 307 U. S. 125. As said by Mr. Chief Justice Stone in the Columbia Broadcasting case, supra, with respect to whether particular action by the Commission constituted a reviewable order: "The particular label placed upon it by the Commission is not necessarily conclusive, for it is the substance of what the Commission has purported to do and has done which is decisive. *Powell v. United States* 300 U. S. 276, 284-85; *A. F. of L.* v. *Labor Board* 308 U. S. 401, 408." And as said by Mr. Justice Frankfurter in his concurring opinion in that case: "If an administrative determination of status has the effect of subjecting a person to legal obligations, whether embodied in statute or previously formulated administrative commands, or otherwise affecting legal rights, such a determination possesses the elements of a reviewable order." A finding by the Commission which determines that past rates are unlawful in a determined amount, and which is to be given effect by a state regulatory body in determining the reasonableness of rates charged on the basis thereof, certainly affects legal rights; and the power of review under the statute should be coextensive with the power of the Commission to make such determination.

"In any view of the matter, therefore, the findings as to past rates are reviewable, and should be set aside for the reasons heretofore given in discussing valuation and depreciation. We are impressed, also, with the thought that the finding as to unreasonableness of these rates cannot be sustained because made on the basis of the utility's experience during the years in question, instead of upon a reasonable estimate of expense based upon experience of a prior period. The reasonableness of a rate must be judged in the light of information available at the time it is charged, not in the light of subsequent developments. It is manifestly impractical to conduct a wholesale natural gas business on the basis of annual changes in rates; and certainly it is unreasonable that rates be condemned retroactively on the basis of facts which could not have been known when they were charged.

"For the reasons stated, the order of the Commission will be set aside and the cause will be remanded for further proceedings."

Reversed and Remanded.

Circuit Judge Dobie rendered a dissenting opinion.

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Effect of Kiln Gases in the Glost Firing of Ware*

By
John H. Koenig
The Hall China Company
(Now in the Armed Forces)

I. Introduction

THE EFFECT of kiln gases on ceramic ware was early recognized by the ceramic manufacturer. Observations on defects resulting from kiln-gas conditions appeared in the earliest publications of the English and American Ceramic Societies. These references described resulting defects and discussed ways of controlling or correcting them. There are many practical observations for which no scientific data are available; there is a great deficiency of basic information.

In this résumé an attempt was made to review all the pertinent literature, including the early historical interest, as well as the more recent work. Industrial experience on observation and elimination of defects and laboratory experimentation were included.

II. Glaze Defects Associated with Kiln Gas Conditions

Various defects on glazed ware which have been related to kiln gas include: "struck effect" from direct flame impingement either oxidizing or reducing, scumming, dulling, iridescence, blistering, roughening, pinholing, spit-out, crystal formation, fuming, effect on surface texture and color. Some of the defects have received other descriptions, as sweat-marks, pock-marks, feathering, starring, metallic sheen, etc. Some references deal with the use of reducing atmospheres to attain certain colors or surface qualities; these will be referred to later collectively.

Early firing methods and fuels used gave more prominence to defects resulting from kiln gases. The muffle kiln was initiated to reduce flame impingement and direct contact of ware with kiln gases. A reducing condition could readily enough exist though without a constant excess of air being supplied, because of gases from the body and glaze plus any diffusion of kiln gases into the muffle. Improved design of direct fired kilns corrected much of the trouble from contact with kiln gases and flame impingement.

For general practice a reducing atmosphere is considered bad for glost firing. Color changes have been usually related to an oxidizing or reducing atmosphere. The scumming types of defects have been mostly credited to sulfur gases and also to these gases when they are present in an oxidizing atmosphere. Water vapor is generally considered detrimental. Fuming is accredited to certain volatile glaze ingredients. The various causes of defects will be treated separately.

III. Combustion Products of Fuels

One must consider the chemistry of the combustion reactions of various fuels. Coal, oil, artificial and natural gas are commonly used. With complete combustion C burns to CO_2, H_2 to H_2O, and S to SO_2. Additional products of combustion are: N_2 (from the fuel and air) and O_2 (excess air). With incomplete combustion there are unburned hydrocarbons and carbon monoxide present.

A comparison of theoretical combustion products of fuels is given in Table I. Excess air will add oxygen and more nitrogen to the results shown. Attention is called to the low moisture content for producer gas. Producer gases and solid fuels show low H_2O and high CO_2. The effect of water vapor in the kiln atmosphere will be discussed later on in this article.

The values in Table I do not give the SO_2 contents separately. The amount of S in fuels varies considerably. The amount of SO_2 generated into the kiln atmosphere under oxidizing conditions can be calculated, knowing the sulfur content of the fuel. For most fuels it would be perhaps less than 0.1 per cent. As will be pointed out, the fuel is not the only contributing source of SO_2, for sulfates are present in body and glaze constituents, as well as in the water used in their preparation.

The effect of other volatile materials and gases in the kiln atmosphere, in addition to those gases generated during the complete or partial fuel combustion, have been recognized. These include: volatile glaze ingredients, gases from the body, the volatile agents used in vapor-glazing, etc.

IV. Effect of Sulfur Gases

Seger remarked in 1902 that the injurious effects of sulfur gases on glazes had (up to his time) been disregarded. He described the defectiveness as a skin formation of wrinkled appearance often with little bubbles. A wide range of defects has been noted by different investigators; these include: scumming, roughness, dullness, crystal skeletons, crystal patches, efflorescence, feathering, color changes, and others.

The sources of sulfur gases, which include more than fuel gases, are:

1. Fuels — should use low sulfur fuels
2. Glaze ingredients, principally clays

TABLE I
COMPARISON OF THEORETICAL COMBUSTION OF FUELS
(From *The Iron Age*, June, 1933)

	CO_2	H_2O	N_2+SO_2	CO_2 (dry basis)
Blue gas (from coke)	17.30	17.67	65.03	21.01
Water gas (carbureted)	14.37	16.45	69.19	17.20
Butane (100%)	11.90	14.88	73.22	13.98
Propane (100%)	11.54	16.05	72.41	13.75
Coal or "Oven" gas	7.83	22.50	69.67	10.10
Natural gas (W. Va.)	11.34	18.01	70.65	13.83
Anthracite Producer gas	17.44	9.69	72.87	19.31
Bituminous Producer gas	16.17	8.23	75.60	17.62
Coke Producer gas	19.08	5.80	75.12	20.25
High Volume Bituminous coal	122.00	8.35	69.65	24.00
Low Volume Bituminous coal	16.50	5.60	77.90	17.50
Anthracite coal	18.90	3.24	77.86	19.53
Fuel coal	15.60	13.20	71.20	17.97

* *Presented at the Annual Fall Meeting of The Ohio Ceramic Industries Association.*

3. Body ingredients—lose some here if ware is bisque-fired
4. Water used in preparing bodies and glazes
5. Soluble sulfates, such as $MgSO_4$ used to thicken glazes
6. Plaster of Paris molds
7. Kiln atmosphere—should be oxidizing and have lowest possible moisture content to minimize effect of sulfur gases present from various sources. Also adequate circulation.

According to Seger, silicic acid expels the sulfuric acid; the decomposition is complete only in the presence of reducing atmosphere (sulfurous acid more volatile than sulfuric) or at high temperatures. Mellor considered the sulfuring of glazes as a surface reaction, caused by the formation of a surface layer of sulfates (S gases react with alkalis, Pb, CaO, etc., and form sulfites and sulfates) which do not have time to diffuse into the glaze and which, on cooling, crystallize. According to him, conditions which appear to be most favorable to formation of a surface film of sulfates are an oxidizing atmosphere at a temperature near the congealing point of the glaze. Shegog considered that there were two forms of sulfuring, one which occurs early in the glost fire due to vesicles of acid-laden moisture condensing on the surface of the glaze, and the other, a scum or film sulfuring occurring later when the kiln is too hot for moisture to condense on the ware. Dettmer pointed out that sulfur causes bubbles and devitrification of colored glazes. It is detrimental to glazes in an oxidizing atmosphere through the formation of sulfates, and in a reducing atmosphere by formation of polysulfides causing discoloration. Kieffer and Czech claim that under reducing conditions at high temperatures SiS_2 is formed which volatilizes at higher temperatures, collects in the deepest parts of the ware due to its high gravity, and gives crystalline patches. Water plays a great role. Under oxidizing conditions very little scumming occurred. Continuing along this line, Dettmer stated that since we can get scumming when firing with wood (which contains little or no S) factors other than S may cause the scumming (other sources of the S gases apparently not considered by Dettmer).

Ortman claims that after the glaze is fused it is not easily susceptible to the chemical action of SO_3 on its surface. The SO_3 taken up either by physical absorption or chemical combination or both may cause blisters on being displaced by SiO_2, may displace B_2O_3 from the glaze, or may react with coloring oxides or fluxes present preventing development of color or texture.

However, there are experimental data which establish the deleterious action of S gases. Several recent investigations are referred to, that of A. P. Watts, and one just completed by Dr. M. W. Bredekamp at the University of Maryland. In addition to extensive experimental work, Bredekamp included a painstaking review of the literature in his thesis.

In one experiment, Watts used an atmosphere of 100 per cent SO_2. The fritted lead glaze tested was a mass of blisters and scummed patches, which destroyed all gloss and roughened the surface. Using a gas 11 per cent CO_2, 5 per cent O_2, 83.5 per cent N_2 and from 0.5 to 0.6 per cent SO_2, glazes showed light scum to dullness and iridescence. When the SO_2 was decreased to 0.25 per cent the glazes had good quality; however, here the atmosphere contained no water vapor. Water vapor, in addition to the above gas with 0.25 per cent SO_2, indicated that H_2O in the atmosphere may aggravate the effects of SO_2. Watts concluded that SO_2 produces scumming and dark patches on the surface of the glaze even when present in the furnace in the amount of only 0.25 per cent. The effect of SO_2 on glazes seems to be partially dependent on the amount of H_2O vapor present. Bredekamp, testing a raw Bristol glaze, found that, with a high percentage of O_2 present in the firing atmosphere, high water vapor content or high dry SO_2 content gave scumming and other textural changes. The colors of various colored glazes (some base glaze) depended upon the amount of excess air and upon the S concentration; the latter tended to lessen the color by causing a surface scum. In order to prevent surface conditions attributed to SO_4, the S concentration in the atmosphere should be lower than 5 grains per 100 cubic feet of combustion products.

Regardless of the mechanism or source, whether insoluble sulfates are crystallized or deposited on the surface or decomposed, or if H_2O soluble sulfates in the glaze (when applied) come to the surface, the detrimental effects of S gases are generally accepted from practical observations and established by experimental findings.

V. Effect of Water Vapor

Several previous references have dealt with the effect of H_2O in the kiln atmosphere, when S gases are present. According to Seger, H_2O condensed in cooler parts of the kiln is responsible for the acid reaction causing solution of colors, and Binns states that H_2O vapor influences color if there is S present. Schramm remarked that H_2O vapor in kiln gases usually plays a part in defects, because gases, which are harmless when dry, may be damaging in the presence of steam. All commercial fuels contain H_2O so there is no possibility of dealing with this by elimination (note here, though, that in some fuels the H_2O formed is less, see Table I). When firing with coal the burden is greater if the coal is not dry. Excess H_2O leads to incomplete combustion, impaired draft, caking, and increases the danger of "gassing." Glaze defects caused by the presence of H_2O are often claimed due to improper oxidation.

In addition to influencing color, H_2O vapor is credited with causing blistering, bubbles, roughness of surface, and textural changes. Water vapor, especially in the presence of NaCl, has been claimed to act as a mineralizer contributing to devitrification. Various theories concerning the action of H_2O vapor include: its reducing action, displacement of O_2, dissociation, and at high temperatures action as a strong acid.

Watts found that using an atmosphere of steam caused bubbles in different types of glazes and darkened the glazes to some extent. Using the gas 15 per cent CO_2, 85 per cent N_2, and H_2O vapor, glazes showed bubbles and the leadless glaze a darkening; when about 5 per cent O_2 was introduced, the defects were corrected to some extent, but not completely. He concluded that H_2O vapor had a very harmful effect on glazes.

Recommendations include: the use of dry fuel which yields less H_2O, also a low S fuel, and having the ware dry when it goes into the kiln.

VI. Effect of Unburned Hydrocarbons

Watts' experiments showed the effect of unburned hydrocarbons in the kiln atmosphere. A fritted lead glaze was subjected to the atmosphere of unburned city gas. In the hot tube of the furnace the hydrocarbons of the gas were cracked, depositing finely divided carbon on the test piece and forming a strongly reducing atmosphere. The C had impregnated both the body and the glaze and had turned both jet black. The glaze did not fuse down to a smooth glossy surface but was rough and pitted. Thus unburned

hydrocarbons may break down in a kiln atmosphere and darken a white glaze and body by the deposition of finely divided C.

Other sources of unburned hydrocarbons and carbon are: carbonaceous materials initially present in the body (chiefly) and glaze ingredients, and deposition of C and unburned hydrocarbons in the ware during the firing, especially where reducing conditions are present. Pinholing and blistering have been considered by some as due to entrapped C. The presence of C in semi-vitreous bisques, fired to cone 9, was shown at the Experiment Station (O.S.U.). If organic matter in the body has been imperfectly oxidized during bisque-firing, entry of air (bodies and glazes are very permeable to hot O_2) during glost firing may cause combustion. One investigator claimed that some forms of glaze blisters may be overcome by higher bisque firing (indicating perhaps more effective removal of the carbonaceous matter). The blistering of glazes results in the glost firing, if the glaze matures before the evolution of the gases from the body has been completed, or if the glaze is caught (by cooling) in a bubbling, boiling condition; the glaze must be thoroughly melted. Spit-out in the decorating kiln bears some relation to blistering in the glost kiln. The absorption of moisture of the bisque on standing and the carbonaceous matter present supply the gases which are evolved from the body at decorating temperatures, at which temperatures the glazes are not sufficiently fluid to heal.

Mellor showed that a glaze can absorb hydrocarbon-gases and Ortman demonstrated that glazes will absorb S from the kiln atmosphere. Gas solution in glasses has been studied. All ordinary glasses contain appreciable quantities of dissolved (or chemically combined) gas. Water is frequently the most abundant, CO_2 is present, the amount depending on basicity, and O_2 is present in oxidized glasses. Some thought has been given to a possible relation between solubility of gases, in the bodies and glazes, and defects caused by different kiln gas conditions.

VII. Effect of Reducing Atmosphere

This has already been discussed under the detrimental effects of H_2O vapor and under the presence of unburned hydrocarbons. As before, a wide range in defects has been reported due to kiln conditions. In addition to blistering, roughening, change in color, loss of opacity, etc., a claim was made that firing certain glazeware under strongly reducing conditions may cause the glaze to craze. Changes in color, the most common observation, is discussed in the section on glazes requiring special atmospheres.

Watts found that an atmosphere of air almost invariably produced good glazes, provided, of course, that the glaze had satisfactory composition. Glazes were good where the atmosphere was entirely O_2. (These tests were made in an electric furnace, the glazed pieces glost-fired under various controlled atmospheres). An atmosphere of N_2 caused bubbles in the glaze; the bad effects were considered to be due to a lack of oxygen. An atmosphere of CO_2 alone caused many minute bubbles in the glaze and a leadless glaze tested had a yellowish discoloration. Atmospheres containing CO produce a yellowish or greyish discoloration in a white glaze, and cause many bubbles and roughness. The effect is still evident when the CO present is only 2 per cent of the furnace atmosphere. A neutral atmosphere of CO_2 and N_2 is often not enough to produce good glazes and is sometimes responsible for inferior ones. An oxidizing atmosphere, in which at least 4 to 5 per cent O_2 is present, is an aid in obtaining good glazes.

Most investigators agree that an oxidizing atmosphere is desirable for general work, but with reducing conditions the surface texture may become blebbular, lose brightness or even become mat, and color changes result.

VIII. Volatilization of Glaze Ingredients, Fuming, etc.

In addition to the gases already discussed as present in kiln atmospheres, certain volatile glaze ingredients should be considered. (This discussion will not include vapor glazing and the agents used.)

Lead is one of the most volatile glaze ingredients. Seger pointed out that with a body fired at low temperature there is recourse to lead glazes. Above 1150° C the lead volatilizes excessively and leadless glazes must be used. Mellor stated that the surface has developed, it becomes losing lead, etc., by volatilization, when it is being fired, and in consequence once the surface has developed, it becomes duller and duller the longer it is fired. Schramm reported that analysis of a dust collected in the exit end of a saggerless glost muffle kiln showed it to consist of 90 per cent PbO and B_2O_3. The stalactite formed at the end of the hot zone also showed a high PbO and B_2O_3 content with smaller amounts of alkalis and other fluxes from the glaze.

In a study on the effect of degree of smelting on the properties of a frit, it was concluded that, in general, the chemical composition of a frit at the point of normal pouring may differ quite materially from the composition which might be expected on the basis of computation. The SiO_2 content is materially higher, the Al_2O_3, CaO, and K_2O are slightly higher, and the Na_2O and B_2O_3 contents are very much lower.

Schramm determined glazes lose by volatilization. It was noted that the thicker the glaze film, the greater the loss in weight. The change in glaze composition (by analysis) showed pronounced increases in the alumina. A decrease in lime, alkalis, and boric oxide was noted. Lime reacted with the body.

On the volatilization of glaze constituents to adjacent surfaces, it was pointed out that there is considerable difference in the receptive quality, the kind, and area of the surface. Close proximity of a glazed piece to a refractory surface, owing to absorption of lead and other volatile ingredients, promotes further volatilization of the glaze. For this reason lead-rich washes have been used on sagger walls to prevent excessive volatilization of lead from the glaze.

The temperatures at which Pb, Cr, and B start to volatilize from a cone 04 glaze was determined spectrographically and found to be: B—450° C, Pb—850° C, and Cr—1000° C. An increase in the SiO_2 content increased the volatilization temperatures of these ingredients. The method of compounding a glaze affects the lead volatility, i.e., the distribution of the composition between the frit and the mill addition.

Of various glaze ingredients in colored glazes which vaporize and fume causing trouble with other glazes, perhaps Cr is the worst offender. Ramsden claimed the volatilization from a transparent chromium glaze was quite small, but this was not true when the glaze was saturated. A case was described where a terra cotta glaze started burning to a pink, and this change was held due to Cr communicated by kiln atmosphere. This scumming, wrinkled, and dry appearance, or color change is caused by condensation of Cr fumes volatilized from the glaze. Glazes containing Zn or low in CaO are more susceptible to this Cr fuming.

Volatilization of Cu occurs from most Cu glazes, being generally greater from a lead glaze. Certain green

Cu glazes have been noted to have a surface film high in copper which could be removed readily by washing in dilute acid. In fact, glazes in the kiln can be colored by Cu as an on-glaze decoration produced by volatilization of Cu from a Cu salt placed close to the ware during glost firing.

Hill noted that certain terra cotta glazes which did not blister at cone 6, blistered at cone 7 when containing 0.3 eq. ZnO. This was held due to the volatilization of ZnO or some Zn compound in the glaze. Some evidences of volatilization of Mn from glazes carrying Mn have been reported by Ramsden. Wilson referred to a rutile color which volatilized in the soaking heat of a large kiln, though by rapid firing in a small kiln good yellows were produced. It is known that Co glazes will sometimes fume.

The fuming of certain glaze ingredients may affect other glazes after the concentration reaches certain limits. In practice the trouble can be avoided by not placing "susceptible" glazed ware near glazed ware which carries the detrimental volatile ingredients, or by placing the ware so fume concentration will not be excessive.

IX. Glazes Requiring Special Atmosphere

The effects of different kiln conditions, nature of atmosphere, whether oxidizing or reducing, presence of certain gases as SO_3 or H_2O, or volatile glaze ingredients, may vary greatly for different glazes. In fact, the susceptibility of even the same glaze formula may be changed by a redistribution of its composition between frit and mill portions. To illustrate, free lead oxide (as added in a raw Pb glaze) is much more easily reduced to metallic Pb by reducing influences than is lead silicate (as in a fritted glaze).

Lead glazes have been repeatedly mentioned as being sensitive to gas conditions. Under extreme reduction lead glazes may come out entirely black due to reduction of lead oxide to metallic lead. This discoloration is usually a grey to a blackish color. In the preparation of lead silicate frits, excess air is a prerequisite to prevent reduction of the lead. It is for this reason better to use red lead than litharge, or especially white lead. In the latter case, the H_2O and CO_2 evolved are obviously potential aids to a state of reduction for a fixed air inflow. This is more troublesome where the mixed frit ingredients are placed directly in the hot furnace so that these gases are evolved more rapidly at temperatures where the Pb is more easily reduced.

Mellor reported on discoloration of Cr-green colors. Colors obtained may be greenish-grey to brown, instead of the desired green. A reducing condition favors the green, the richest colors being produced from calcines which were fired in a reducing atmosphere. It is not unlikely that the SnO_2 present in a Cr-green may, in an oxidizing atmosphere, form some Cr-Sn crimson. A reducing atmosphere is necessary to get the best results from the Cr-greens, but an oxidizing atmosphere is needed for the Cr-Sn colors.

Hull discussing Cr-Sn glazes with enough addition of SiO_2 to get a red color mentioned that this red color was destroyed by reducing conditions but could be renewed on continued oxidation.

Regarding Cr-Zn browns it is claimed that the colors are produced by Zn chromates which are influenced by kiln conditions rather than through an oxidation of Cr_2O_3 to higher forms.

The sensitiveness of red uranium glazes to reducing conditions has been pointed out. Using only uranium oxide in a lead glaze, a shade from light yellow to deep orange or almost a red may be obtained by simply varying the quantity. Black spots noted in such glazes are undoubtedly due to the reduction of large masses of yellow uranium oxide (U_3O_8) to the black oxide (UO_2). It cannot be due to high temperatures alone, since all oxides of uranium are changed to the yellow U_3O_8 upon being heated to high temperatures in the presence of air. A cream-colored uranium glaze requires oxidizing conditions and may be discolored into green to black in a reducing atmosphere.

There has been considerable work on the development of Cu-red in a reducing atmosphere. The color is due to the reduction of CuO to a colloidal solution of metallic Cu, while a blue or green color is obtained in an oxidizing atmosphere. Cu-red glazes are sometimes produced by reducing the surface of the glaze only. For this purpose, the glazes are fired in a muffle first with intense reduction, then in an oxidizing or neutral atmosphere, and after they are fused, a reducing atmosphere is introduced. Unless the cop-

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per content is limited, completely black reduction will occur in spots. The glaze composition is less important than correct firing conditions.

Baggs and Littlefield demonstrated the possibility of producing localized, definitely controlled effects of reduction, in oxidizing or neutral atmospheres, through the use of glazes of special composition (using silicon carbide in glaze or underglaze slip). In ordinary kiln atmospheres both methods produced satisfactory results in which predetermined areas of Cu-reds and Cu-blues were developed on one piece.

Berdel discussed turquoise glazes pointing out that CuO will color lead glasses green and alkaline glasses blue. Naturally, a sharply oxidizing fire is necessary and for this reason the "oxidizing" red lead is a better ingredient than litharge.

Aventurine glazes vary in color from red to black according to the kiln conditions, the red being produced under oxidizing conditions and the black under reducing conditions.

The foregoing examples (and there are many more) serve to illustrate the effect of kiln conditions on various colored glazes.

X. Metal Marking of Whiteware Glazes

A study was made at the Bureau of Standards to determine the influence of S and C in the kiln atmosphere on metal marking of whiteware. Conclusions were: The glaze surface, in so far as susceptibility to metal marking is concerned, was not affected by CO. The concentration of SO_2 gas in the furnace atmosphere as high as 1.2 per cent did not produce a surface at 860° C on any of the specimens tested which could be metal marked. The only glaze showing harmful defects (blisters) after exposures to from 0.1 to 1.2 per cent SO_2 was on a colored vitrified body. Increasing the concentration of SO_2 from 0.1 to 1.2 per cent SO_2 increased the susceptibility of the surfaces to scratching with metal, particularly nickel and steel. Three per cent SO_2 in the furnace atmosphere was sufficient to so dull the glaze on two typical hotel ware and two earthenware bodies as to make them appear almost completely mat. The only specimens tested which would "metal mark" were of one brand of vitrified, relatively low-fired ware. Concentration of SO_2 of 3 and 5 per cent caused this glaze to metal mark, but produced no blistering or scumming detectable macroscopically. Concentrations of 7½, 10 and 12½ per cent SO_2 produced a slight scum and impaired the gloss; evidence of marking could not be entirely removed by washing after exposure to a concentration of 12½ per cent; and the scum formed was composed at least partly of $PbSO_4$.

XI. Recent Work on Leadless Glazes

In Germany war has brought back a problem which they had during the last World War, the elimination of lead and boric acid in whiteware glazes. There it is generally considered that lead-free glazes are more sensitive to sulfur in kiln gases than glazes containing lead. Steger's recent experimental work indicated that glazes with good resistance to kiln gases containing sulfur could be made with suitable composition. Na_2O and Li_2O must be avoided, therefore borax cannot be used. CaO should replace Na_2O. BaO should be omitted from the lead-free glaze. Part of the harmless CaO can be replaced by MgO. The best content of boric acid is about 15 per cent with 55 per cent SiO_2 in the melted glaze. There have been a number of researches in Germany along these lines.

XII. Effect of Furnace Gases on the Quality of Porcelain Enamels

It is of interest to refer to the work that has been done in the field of enamels. Staley in 1918 pointed out that the detrimental effect of certain gases on enamels was fully realized, but that very little definite information was available. The effect of sulfur gases has since received some attention and it is universally considered that sulfur gases are very undesirable constituents of the enamel furnace atmosphere. The necessity of maintaining oxidizing conditions in the furnace has been studied by others.

Andrews and Hertzell studied the appearance of enamels fired in atmospheres of N_2, CO_2, SO_2, and city gas. They found that the presence of unburned or partially burned gas and SO_2 in the furnace gases was detrimental to the enamels fired therein. Of side interest was the fact that variation of the composition of groundcoats produced little or no variation in their resistance to attack by sulfur gases, while variations in the composition of certain cover coats produced large variation in their resistance to such attack.

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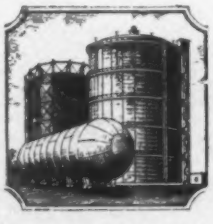

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Air Conditioning Small Commercial Establishments With Gas

A Report of Practical Results

By
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New Orleans Public Service Inc.
New Orleans, La.

THE UTILIZATION of gas for year-round air conditioning has grown steadily during the past several years and has attracted much interest within the industry. Many papers have been written on progress in applying small year-round conditioners to the residential field, but little has been said about the interesting commercial market for such equipment. Over fifty percent of the experience in the south was had with the commercial field. The studies and observations in connection with these experiences should form a substantial and valuable, background for post-war planning on the part of those who will actively promote gas all year air conditioning when peace is ours once again.

Although the experience and observations presented herein are confined to the territories served by New Orleans Public Service Inc. and United Gas Corporation, they are representative of many other sections of the country. This paper is written in the spirit of sharing with others, some of the more important things that have been learned in connection with air conditioning commercial establishments with gas.

Status of Development of Small Gas Air Conditioning Equipment

During the past three years, twenty-seven gas utilities have made hundreds of gas air conditioning installations throughout this country. Reports from all sections support experiences in the south, and indicate that the equipment gives a good account of itself. In the southern areas served by United Gas Corporation and New Orleans Public Service Inc., 103 out of a total of 166 units were installed in commercial establishments; which installations represent in excess of 200 unit-years of satisfactory experiences. There is ample proof that the equipment is proved and acceptable.

Character of the Commercial Market

The commercial market for gas air conditioning has interesting characteristics quite different from other fields. In fact, it is almost unique.

Here is a market *already* developed by the electric industry where appreciation of need and value of air conditioning is well established, and where one sale practically forces another. In this market, investment cost and operating expenses are not considered luxuries, but are classed as normal business necessities.

The salesman emphasizes particular type of equipment being offered and confines his attention to showing commercial prospects how the place may be conditioned and the advantages his system has over other methods.

Analysis of the Commercial Market

Consideration will be given first to *where* the equipment has and can be installed, and second to *what extent* the commercial market may reasonably be expected to expand in the future.

Installations have been made in nearly every one of the following classes of establishments:

1. **Apartments**
2. **Banks (small)**
3. **Clubs (sections)**
4. **Clinics**
5. **Offices**
   - **Professional**
   - **Private**
   - **General**
6. **Shops**
   - **Apparel**
   - **Barber**
   - **Beauty**
   - **Book**
   - **Fur**
   - **Sandwich**
7. **Stores**
   - **Candy**
   - **Drug**
   - **Grocery**
   - **Jewelry**
   - **Hosiery**
   - **Shoe**
   - **Sporting goods**
8. **Studios**
   - **Art**
   - **Broadcasting**
9. **Special**
   - **Research**

In general, the commercial market under consideration comprises all es-

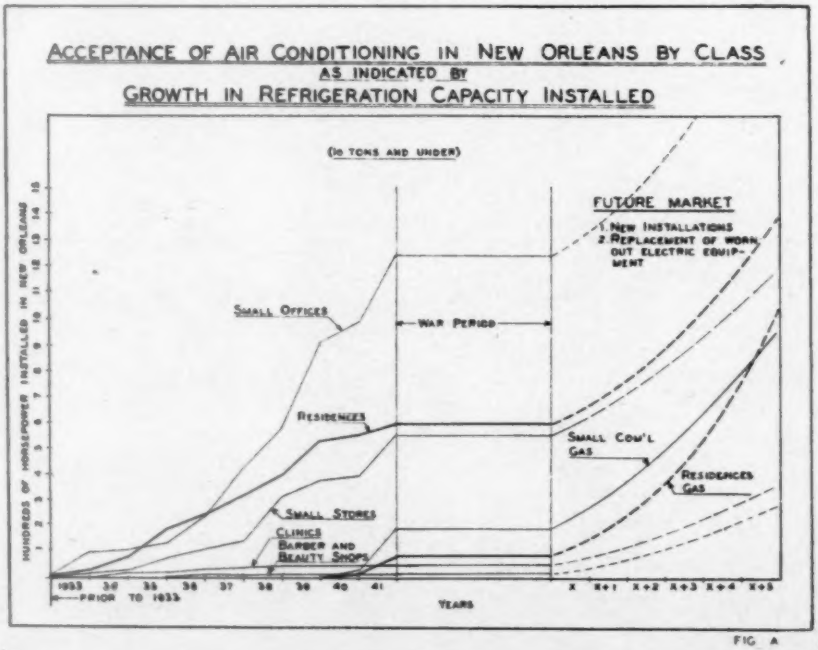

FIG. A

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* *Chairman, A.G.A. Technical Advisory Committee on Gas Summer Air Conditioning Research.*

Note: *Presentation of paper was accompanied with illustrations and additional chart data.*

tablishments with relatively small heat loads from people and moisture. This eliminates funeral parlors, restaurants, cafeterias as suitable applications for small gas air conditioning equipment of present design.

It is very encouraging to learn of the past growth in acceptance of gas air conditioning in commercial establments, and at this time, many plans are being made toward the future for such equipment.

Certain definite trends have been established for commercial acceptance of air conditioning by the electric industry and furnishes an interesting base for predicting future growth of gas air conditioning. Figure A indicates growth of electric air conditioning since 1933, expressed in terms of installed capacity. While these data are for New Orleans only, it generally is representative of the rate of growth elsewhere. Assuming no further growth during the war, it is reasonable to expect a sharp increase for the first several years following the war's end, so that at year X + 2, the rate of increase will probably exceed that prior to December 7, 1941.

It is expected that this growth will be further accentuated by the need for replacement of worn out and obsolete electric equipment, and there, gas should have many natural advantages.

Of course, the actual business secured for gas equipment will depend upon how well the industry sells the advantages of gas and will be directly proportional to such efforts.

It is an interesting and significant fact that over 50% of the gas air conditioning installations made in New Orleans and United Gas Corporation territories are in commercial establishments although all sales promotional efforts were directed at the residential field. Since this is true, it is reasonable to assume that a much greater volume of commercial business could be had with a well directed sales program.

Characteristics of Commercial Air Conditioning Systems

Design and installation of a commercial air conditioning system is relatively simple compared with other types. This is a result of many factors, the more important of which will be mentioned herein. As a result, commercial installation costs are lower than others, expressed both in terms of cost per sale and system cost.

Psychrometric requirements are not too exacting so that the control elements are reduced to a very minimum. With frequently opened doors, and the great variance in ideas of comfort between employee and customers, no fine control over temperature or humidity is justifiable.

NO. OF INSTALLATIONS	12	13
INVESTMENT COST COMPARISON	RESIDENTIAL	COMMERCIAL
INVESTMENT COST PER TON	$462.	$378.

FIG. B.

Particularly in small stores, offices, etc., the air distribution system often consists of no more than a single supply and return grills in a back wall close to position of the conditioner. Short ducts, with a minimum of insulation, involving simple design, effect a minimum in cost of materials and labor. Then too, the location of the conditioner is often the site of adequate water, electric and gas services, so that a minimum in plumbing and wiring is needed to "connect up" the unit.

Careful design of costly acoustic treatment is seldom required because of normal high background noise levels generally found in commercial establishments. Likewise, since appearance is not of prime consideration, exposed duct work is often acceptable and expensive decorating seldom required.

All of these items have a favorable effect on investment cost, more clearly seen by examining Figure B which compares cost of commercial with residential installations.

Another interesting characteristic of many commercial systems is that their operating time and cost are not greatly influenced by the weather, such as in the case of a residence. Figure C shows operating costs for a drug store, shoe store, and a general office, contrasted with a residence. Note the flat curve indicating more constant use in case of the shoe store which is least affected by the weather, and the sharp peak in residential use —a more direct influence of weather.

In all cases, however, it should be emphasized that the maximum gas use occurs during summer time—off system peak, and represents increased profits from existing investment for the utility.

An interesting fact about commercial systems is that design is based upon future loads imposed by expected increased business resulting from installation of air conditioning service. In almost every other case, the design is based on existing or known requirements.

Buying Motives and Commercial Sales Appeals

Experience in selling air conditioning to commercial establishments has taught that special, well suited sales appeals must be used which do not apply to other markets. The buying motives which have been found most effective are listed below in their

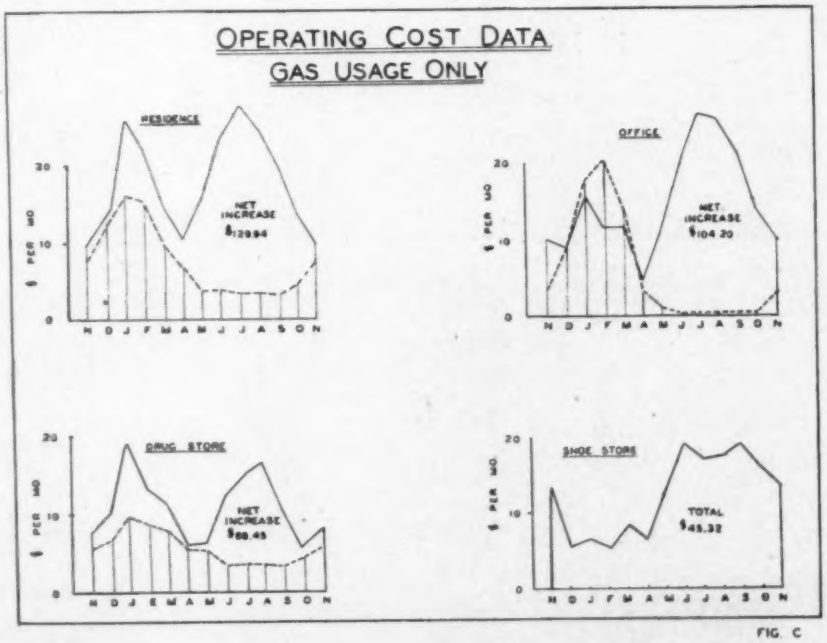


FIG. C

order of importance and are shown in contrast with those which are considered best suited for the residential market. The difference in character between the two groups is quite sharp and interesting.

Of even greater interest are the buying motives which have influenced selection of gas air conditioning equipment. They are summarized below, in their order of importance, according to experiences with commercial establishments in the south.

SALES APPEALS FOUND MOST EFFECTIVE

RESIDENTIAL (PERSONAL)	COMMERCIAL (PROFIT)
1. Comfort	1. Increased patronage
2. Health	2. Increased sales per patron
3. Cleanliness	3. Overcome seasonal slump
4. Noise elimination	4. Loss reduction
5. Personal efficiency	5. Cleanliness
6. Privacy	6. Advertising value
7. Aid to convalescence	7. Prestige
	8. Good will

Buying Motives Influencing Selection of Gas Equipment

1. **Heating and cooling from one unit**
2. **Simple control for seasonal change-over**
3. **No moving parts and long life expectancy**
4. **Cleanliness of gas as one fuel for all seasons**
5. **Replacing obsolete heating equipment**
6. **Compactness**
7. **Silent operation**
8. **Seldom requires enlargement in utility services**

The owner is interested in item #8 because it saves unnecessary costs to enlarge electric, gas or water services.

The utility is particularly interested in item #8 because no further investment in service is required in order to create additional gas revenue.

Experiences With Users Before and After Purchase

Without a doubt, early promotional efforts were aided greatly by the fact that the local gas utility stood behind the program and equipment. No other agency could have done as much in offsetting the public hesitancy to buy a new thing for the first time. And no other agency has had the ultimate interest or the financial capacity to see commercial gas air conditioning off to a good start. The first few installations had to almost be "given away" in order to convince the *Utility* and the *User* that the program was sound. The enthusiastic interest of the user soon radiated, influenced others to consider gas air conditioning equipment and the acceptance began to spread rapidly.

The investment cost seldom influences selection of commercial gas air conditioning, but it is a common experience to show a considerable savings in operating expenses. In the case of a large clinic, a large premium was paid in first cost because operating savings over competitive systems paid off the premium in approximately three years.

On the other hand, this was not the only reason for selecting gas equipment.

Probably the most interesting and gratifying experience with users followed purchase. Indications of satisfaction come in several forms. A great majority of the testimonials which have been received, were voluntary on the part of the owner. They were prompted by personal delight in results of purchase. These letters thanked for good service, mentioned noticeable growth in business, improved customer good will and other tangible benefits. In the case of a Sandwich Stand, the owner announced his intention of buying gas air conditioning equipment for each of his other stands. Still another owner states that he now wants a gas system for his home. Owners have, of their own accord, invited friends to see "their system" and thereby created new prospects. These facts certainly bespeak the disposition of satisfied users.

Conclusions

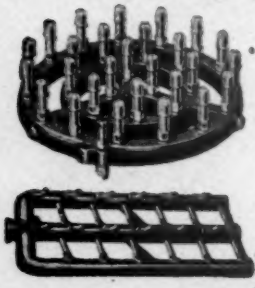
Now practical equipment is available. A broad market for commercial air conditioning installations can be developed when the war is over.

In order to sell commercial establishments, special sales approach and appeals are required. Gas air conditioning systems offer tangible advantages over competitive equipment.

Coordinated efforts of manufacturers and utilities to maintain all installations in satisfactory operating condition will go far toward preserving user good will and will result in a fine springboard for future sales promotion.

Active utilities have increased from two to twenty-seven in approximately three years. There is every reason why *all* gas utilties should be prepared to promote this highly desirable business when the war is over. But—a great deal of post-war planning and preparation is required of those who will be ready when the green light is ours once again, so the time to start is *NOW*.

BARBER BURNERS
For All Gas Appliances



Our facilities are now mainly employed on war work. For those limited purposes for which our regular line of products is permitted, we shall continue to supply them. Later, when normal conditions are restored, Barber will furnish its customary service to the trade on high quality Burners and Regulators.

Latest Catalog on request.

THE BARBER GAS BURNER CO.
3704 Superior Ave. Cleveland, O.

CLEVELAND

"A" TYPE METERS
"B" TYPE METERS
DIAPHRAGMS

Cleveland Gas Meter Co.
2180 East 65th St., Cleveland, Ohio ESTABLISHED 1895

(Continued from page 33)

to save the drain on critical materials.

c. In so far as it is possible, build up storage of gas in underground reservoirs to be used during the next winter season.

In the matter of conversions, this will require close coordination with all agencies concerned with fuel, fuel oil, coal, natural gas, and manufactured gas, and must take into consideration the amount of critical materials involved in conversion, and the shutdown time that will be involved in converting critical plants.

We are in a war, and a very serious war—the winning of the war should be uppermost in the minds of all of us; therefore, in approaching these problems, we should lay aside all selfish motives and post-war positions that will in any wise delay or interfere with the prosecution of the war. When we have won the peace, you can then, I am sure, readjust your business to meet the conditions that exist at that time.

You may be assured that the Armed Services are fully aware of the many problems involved in supplying the Armed Services, essential industries and civilians with fuel, and are cooperating fully with all Governmental agencies who are directing the production, distribution, and utilization of fuel. I should like to quote an excerpt from a letter dated February 22, 1943, from Mr. Krug, Director of Office of War Utilities, addressed to Robert Allen, Assistant Deputy Petroleum Administrator for War: "The office of War Utilities will release off-peak natural gas for fuel oil replacement on application from consumers engaged in war industry and essential civilian activities."

It is particularly pleasing to learn that in the city of Detroit, where industry has done such an outstanding job of converting many plants to war production, industry has already arranged for the conversion of eight large plants from the use of fuel oil, to off-peak natural gas service. The initial conversions, of which we have a record, will provide 300,000 barrels of additional fuel oil annually for other uses. Through the efforts of the group here represented, and other interested agencies, it should be possible to multiply this quantity greatly throughout the nation.

War Production Board and Other Administration Orders

Part 989 - Domestic Mechanical Refrigerators

Supplementary Limitation Order L-5-d as Amended March 27, 1943

(b) **Restrictions on transfers of new domestic mechanical refrigerators.** No person shall transfer or accept transfer of any new domestic mechanical refrigerator except as permitted under the provisions of this paragraph (b). Whenever any manufacturer or distributor is authorized to transfer new domestic mechanical refrigerators under subparagraph (3) of this paragraph (b) or under paragraph (c) (2) (iii), such transfers shall be made as far as is practicable through his normal distributive outlets on a basis proportionate to his distribution of new domestic mechanical refrigerators to them, respectively, during the year 1941, regardless of any previous commitments or contracts.

(1) Any new domestic mechanical refrigerator may be transferred pursuant to a certificate of transfer under the provisions of paragraph (c) or pursuant to other specific authorization of the War Production Board.

(2) Any new domestic mechanical refrigerator may be transferred in fulfillment of any contract or purchase order for delivery of any such refrigerator to or for the account of the Army or Navy of the United States, the United States Maritime Commission or the War Shipping Administration.

(3) Any new electric or gas (but not kerosene) domestic mechanical refrigerator which at 10 A. M. Eastern War Time, February 14, 1942, was in the inventory of a dealer, independent distributor or any other person not a manufacturer or affiliated distributor, may be transferred by any person to any other person without limit as to the number of transfers which may be made of any such refrigerator: *Provided,* That any transfer of a new domestic mechanical refrigerator to an ultimate consumer under the provisions of this subparagraph (3) may be made only if such transferee executes a purchaser's certification, on Form PD-833, which is countersigned by the transferor.

Any new electric or gas domestic mechanical refrigerator which at 10 A. M. Eastern War Time, February 14, 1942, had been bought and fully paid for and was in the hands of the seller at that time, shall be deemed to have been in the inventory of the purchaser at 10 A. M. Eastern War Time, February 14, 1942.

(5) Any person may distrain or levy by execution, attachment or similar form of judicial process, on any new domestic mechanical refrigerators, or repossess them on default, but may not transfer them thereafter except pursuant to the provisions of subparagraphs (1) and (2) of this paragraph (b) unless the refrigerators come within the provisions of subparagraph (3) of this paragraph (b).

(c) **Transfer of new domestic mechanical refrigerators by a certificate of transfer.**

(2) A certificate of transfer on Form PD-430 may be issued in order to permit the transfer of new domestic mechanical refrigerators:

(i) From one warehouse or place of storage to another warehouse or other place of storage, whether or not it involves any change in the ownership or title of such refrigerators;

(ii) From any person to any other person when the transfer does not come within the provisions of subparagraph (1) of this paragraph (c); or

(iii) From any manufacturer, affiliated distributor or independent distributor without limit as to the number of transfers which may be made of any such refrigerators to any person other than a person acquiring refrigerators for export to and consumption or use in any foreign country: *Provided,* That

(a) The words "unlimited transfer" appear on such certificate; and

(b) Any transfer to an ultimate consumer made under the provisions of this subdivision (iii) of this paragraph (c) (2) may be made only if such ultimate consumer executes a purchaser's certification on Form PD-833, which is countersigned by the transferor.

Whenever such certificates for "unlimited transfer" are issued by the War Production Board it shall take into consideration the number, price range, size and type of new domestic mechanical refrigerators in the stocks

of manufacturers, affiliated distributors, and independent distributors on February 14, 1942 and thereafter;

(iv) From any manufacturer, affiliated distributor or independent distributor without limit as to the number of transfers which may be made of any such refrigerators to any person acquiring refrigerators for export to and consumption or use in any foreign country: *Provided*, That the words "export transfer" appear on such certificate.

(g) *Reports.* * * *

(2) Each affiliated distributor or independent distributor shall file with the War Production Board on or before the next business day after any shipment to or from his stock of refrigerators, a report of all such shipments on Form PD-431. Any refrigerators received pursuant to Form PD-430 marked "unlimited transfer" which are set aside by an affiliated distributor or independent distributor for direct shipment by such affiliated distributor or independent distributor to ultimate consumers shall be reported on Form PD-431 as a group when set aside and not as individual transfers to ultimate consumers.

Issued 27th day of March, 1943.

400,000 Household Refrigerators To Be Released This Spring

Approximately 400,000 household refrigerators — almost half of them electric or gas-operated and the other half non-mechanical "ice boxes"— will be available to the general public this spring, the WPB Consumers Durable Goods Division announced. Most of the refrigerators released will be of six, seven, or eight cubic feet capacity, deluxe models.

Only those who cannot be served by other types of refrigeration are eligible to buy gas or electric refrigerators, and each purchaser must attest, on a Government form supplied by his retailer, that "the domestic mechanical refrigerator being transferred is required by me. . . . I have no other domestic mechanical refrigerator, nor do I have available any other refrigeration equipment which I can use. . . . " This form is available to the purchaser, as a part of the sales transaction, from his dealer. It will not be supplied at WPB offices.

Subchapter C-Director, Office of War Utilities

Part 4500-Electric, Gas, Water, and Steam Utilities: Materials

4500.5 **Supplementary Utilities Order U-1-d.** Notwithstanding the provisions of paragraph (h) of Utilities Order U-1, electric, gas and water facilities may be built by producers to serve premises, the construction or remodeling of which is authorized under paragraph (b) (4) of Limitation Order L-41 by the issuance of a specific direction, order, certificate, or other authorization for construction: *Provided*, That the following conditions are satisfied:

(a) **Industrial or commercial consumers.** (1) The cost of material for such utility facilities is less than $1,500 in the case of underground construction, or $500 in the case of other construction;

(2) Facilities can be built with an expenditure (including service drop or service pipe and any portion built by or for the consumer) of not more than 60 pounds of copper in conductor for electric service, 250 pounds of iron or steel pipe for gas service (or the equivalent length of lead or lead alloy pipe or tubing) or 250 pounds of iron or steel pipe for water service, and the producer has so certified in a letter addressed to the War Production Board and attached to the builder's application for L-41 approval. Each producer must preserve on its own books a record of each work order, job, or project initiated under this paragraph.

(b) **Domestic consumers.** (1) The cost of material for such utility facilities is less than $1,500 in the case of underground construction, or $500 in the case of other construction;

(2) The electric, gas, or water facilities (including service drop or service pipe and any portion built by or for the consumer) can be built within the limits established by the Housing Utilities Standards, issued by the War Production Board, and the producer has so certified in a letter attached to the builder's application for L-41 approval. Each producer must preserve on its own books a record of each work order, job, or project initiated under this paragraph.

Issued 29th day of March, 1943.

Controlled Materials Plan

Petroleum operators and mining and utilities producers have been exempted from the inventory provisions of Controlled Materials Plan Regulation No. 2, Harold Boeschenstein, Director of the Controlled Materials Plan Division, announced March 27. As a result of this exemption from the inventory provisions of CMP, these operations revert to limitations imposed in P-98-c, P-56, and U-1, respectively.

Electric power, natural and manufactured gas, water, and central steam heat suppliers, included within the scope of utilities, are exempted from the terms of CMP Regulation No. 2 and will continue to be governed by the inventory provisions of Utilities Order U-1. Under this order, no producer engaged in any of these activities may schedule for delivery to himself during a calendar quarter any material to be used for maintenance, repair and operating supplies, or for any other purpose other than authorized additions and expansions the aggregate dollar volume of which exceeds one-third of the aggregate dollar value of withdrawals of material of the same class from inventory during the last nine months of 1942. In addition it is also provided in the case of electric power producers that not more than 50 per cent of permitted deliveries of wire, cable and bus bar may be scheduled for delivery from a supplier other than another producer of electric power. In the case of producers of gas, water, central steam heat, and public sanitation, not more than 75 per cent of permitted scheduled deliveries of iron and steel pipe may be scheduled for delivery from other than another producer by such utilities.

In general, it is further provided that utilities may not accept delivery of any material to be used as maintenance, repair, or operating supplies, or for any purpose (other than authorized additions and expansions) if their inventory of materials of the same class is, or will become because of acceptance of the delivery, in excess of a practical working minimum. Specific practical working minimums are defined in the order for certain types of materials used by the various utilities.

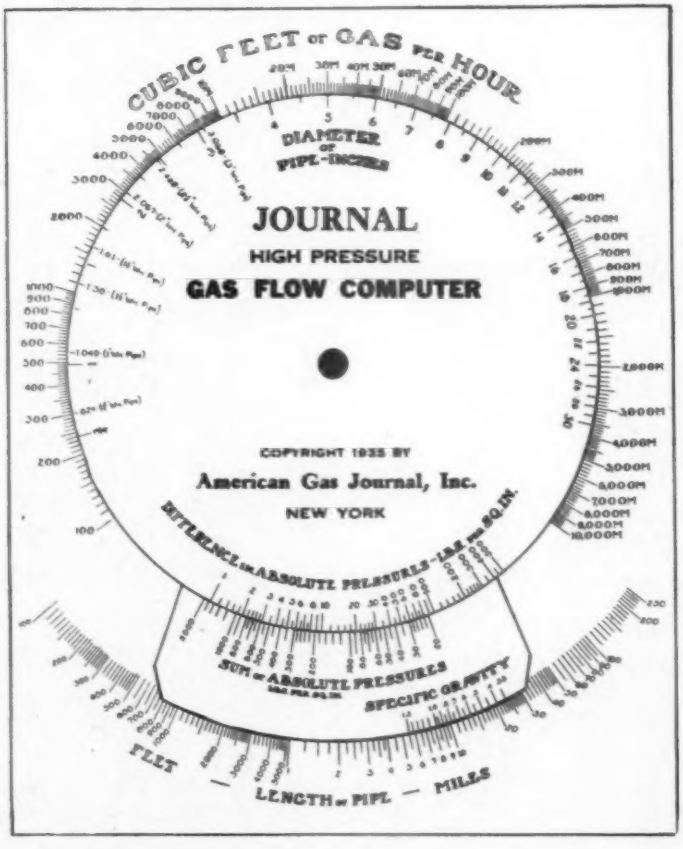
Synthetic Rubber Tires Give Good Service

Successful application of synthetic rubber to industrial tires in operation in one of the country's largest steel mills is reported by The B. F. Goodrich Company.

Four experimental tires, constructed entirely of synthetic rubber were built, two of the 22x16x16 and two 22x12x16. They are of the Press-On type, for use on industrial power trucks and are being operated in the plants of the Jones & Laughlin Steel Corporation at Pittsburgh.

Latest reports on the tire performance is that they are holding up as well as tires made of natural rubber which previous to the rubber shortage were used in this type service.

"Journal" Gas Flow Computers



New Improved Gas Flow Computers now available of durable celluloid, encased in a convenient leatherette cover with complete instructions.

Actual Size 6¼ x 7½

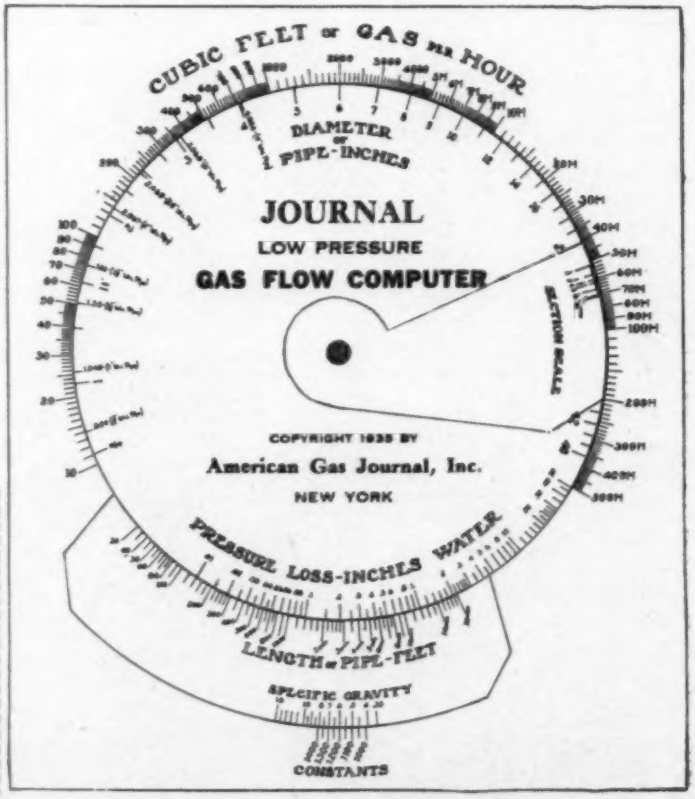
High Pressure Computer Range:

Cu. Ft. of Gas Per Hour—100-10,000 M
Diameter of Pipe Inches ¾-30
Difference in Absolute Pressure—Lbs. per sq. in. 1-500
Sum of Absolute Pressures—Lbs. per sq. in 2000-20
Specific Gravity 1.5-.35
Length of Pipe—Feet 100-5000
Length of Pipe—Miles 1-250

Low Pressure Computer Range:

Cu. Ft. of Gas Per Hour—10 to 500 M
Pipe Diameter ¾" to 48" (including standard and actual weight up to 4")
Pressure Loss Inches .01-10.
Length of Pipe—Feet 30-30,000
Specific Gravity 1.5-.35
Constants 1400-1000

Price $3.50 Each. Postage Prepaid



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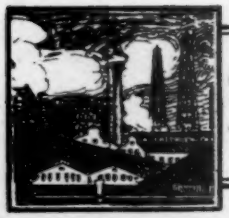


News of the Gas Industry

Production and Chemical Conference of American Gas Association

This Joint Conference to be held at Hotel Pennsylvania, New York, on May 24th and 25th will be devoted to new chemical developments and refinements in gas production, many of them influenced by the war situation.

A. G. A. reports on research projects and authoritative papers on gas production, plant maintenance and repair will be presented. There will be two morning business sessions and three roundtable luncheon meetings.

Luncheon meetings on the 25th will cover subjects as follows: Water Gas—P. T. Dashiell, chairman; Chemistry in Industry—Dr. Frank H. Dotterweich, chairman; Coal Carbonization—A. C. Sedlachek, chairman.

A post-war symposium will be conducted by A. M. Beebee of Rochester Gas and Electric Corporation, who is chairman of the A. G. A. Post-War Planning Committee.

E. W. Zimmerman, Eastern Gas and Fuel Associates, Everett, Mass., chairman of the Gas Production Committee, and T. L. Robey, Washington Gas Light Co., Washington, D. C., chairman of the Chemical Committee, will alternate as presiding officers.

The program follows:

May 24th, 10 A.M.

Chairman's Opening Remarks E. W. Zimmerman.

Greetings. Alexander Forward, Managing Director, American Gas Association.

Address. E. R. Acker, Chairman, A. G. A. Committee on War Activities.

Two-Shell Water Gas Set. D. S. Reynolds, Vice-President, Boston Consolidated Gas Co., Boston, Mass.

Approved Apparatus for Rapid Determination of Traces of Carbon Monoxide. Louis Shnidman, Lab. Dir., Rochester Gas & Electric Corp., Rochester, N. Y.

Report on Organic Sulphur Research. Dr. E. W. Guernsey, Chairman, Subcommittee on Organic Sulphur, A. G. A.

1:00 P.M.
Round Table Luncheon Conferences

Luncheon No. 1

Water Gas. P. T. Dashiell, Chairman, Vice-President, The Philadelphia Gas Works Co., Philadelphia, Pa.

Luncheon No. 2

Chemistry in the Gas Industry. Dr. F. H. Dotterweich, Chairman, Texas College of Arts and Industries, Kingsville, Tex.

Luncheon No. 3

Coal Carbonization. A. C. Sedlachek, Chairman, Philadelphia Coke Co., Philadelphia, Pa.

May 25th, 9:30 A.M.

Chairman's Opening Remarks, T. L. Robey, Post-War Symposium. A. M. Beebee, Presiding, Chairman, A. G. A. Committee on Post-War Planning.

Reports of Committee Chairmen on the Four Basic Studies:

Post-War Purchasing Power and Potential Markets. C. V. Sorenson, Supervisor of New Business, Northern Indiana Public Service Co., Hammond, Ind.

Factors Affecting the Realization of the Potential Markets. R. J. Rutherford, Vice-President, Worcester Gas Light Co., Worcester, Mass., and R. E. Ginna, Assistant to President, Rochester Gas & Electric Corp., Rochester, N. Y.

Engineering and Economic Aspects of Our Own Ability to Satisfy the Potential Markets. Hall M. Henry, NEGEA Service Corp., Cambridge, Mass.

Effects of National Planning and Trends. Walter C. Beckjord, Vice-President and General Manager, Columbia Gas & Electric Corp., New York, N. Y.

Nitric Oxide removal at Boston.

Maintenance and Repairs During the Emergency.

Reformed Gas Oil.

Gas Enrichment.

12:30 P.M.

Luncheon Conference on War Emergency including, "How the gas industry personnel is to be rated and regarded"—by a representative of the A. G. A. Committee on Personnel Practices.

Bimonthly Billing a Success in Commercial Dept. of Brooklyn Union

Some interesting side lights revealing the economics in paper, machines and manpower achieved by reading meters and rendering bills on a bimonthly instead of a monthly basis was presented at a Brooklyn Union Gas Co. conference recently.

Four divisional managers of the Commercial Department told how the change-over affected the meter reading group, the customer accounting aspects, the credit and collection angles, and the effect on customer relations.

All reported that bimonthly billing has proved itself a distinct contribution toward the war effort. Vast quantities of paper are saved. Complex machines which can not be replaced for the duration have had their useful life greatly extended. The manpower saving has made possible a relatively smooth adjustment to the demands of Selective Service on BU personnel.

Customers appear to like the new system, since it cuts in half their trips to company offices. Very few complained, and virtually 100% of those who did appeared happy after receiving an explanation as to why the change was necessary.

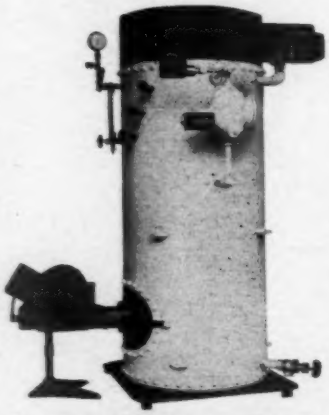
Mailing Rates to Customers

Expenses of more than $5,000 a year will be saved by a Wisconsin utility by a Commission order rescinding a former ruling requiring the utility to mail copies of its rates to all of its more than 250,000 customers twice a year. Some confusion also will be saved, for each time a copy of the rates has been sent out some customers have thought that they indicated new rates had been established.

For Home Insulation

Manufacture of mineral wool for home insulation in 1943 will exceed the output of any previous year, Wharton Clay, Secretary of the National Mineral Wool Association stated recently. He predicted that enough wool will be produced to insulate 600,000 houses, at an average of one ton per house.

LATTNER
GAS — OIL BOILER
3 HP to 35 HP.



Burns natural gas or regular furnace oils with equal efficiency.

P. M. Lattner Mfg. Company
Cedar Rapids, Iowa

New Orleans Public Service Co. Announces Appointments

Appointment of Clayton L. Nairne, General Superintendent Gas Department, as Assistant to the Vice President in Charge of Operations for New Orleans Public Service Inc. has been announced by Harold E. Meade, Vice President of the company.

Clayton L. Nairne

Succeeding Mr. Nairne as General Superintendent of the Gas Department is Jeffrey H. Collins, who has been Superintendent of the Distribution Division of the Gas Department for the past three years. Mr. Collins, who will soon have

Jeffrey H. Collins

an anniversary of twenty years continuous service with the company, has served as chemist and Assistant Superintendent of Gas Production, as Assistant and Superintendent of the Meter and Appliances Division before becoming Superintendent of the Distribution Division.

Mr. Collins is a native of New Orleans having received his primary education there before graduation from Tulane University. He has served on numerous committees of the American Gas Association, and was named Chairman of the Committee on Meters and Metering in 1942.

Mr. Nairne becomes Assistant to the Vice-President after fifteen years employment with the company, occupying several different positions in both the Electric and Gas Departments.

He has held the position of Betterment Engineer at the Fort Lauderdale Steam Electric Generating Station of the Florida Power & Light Company.

Mr. Nairne was educated in New Orleans at Rugby Academy and received his Bachelor of Engineering Degree from Tulane University in 1924. He has been active in the Association of Commerce, Board of Trade, Louisiana Engineering Society, as well as many other civic and trade associations.

Indiana Gas Assn.

The Board of Directors of the Indiana Gas Association at its meeting in Indianapolis on March 26 voted to hold no convention of the Association in 1943. Instead, its "Annual Meeting" this year will be an "open" Directors' meeting at the Claypool Hotel in Indianapolis on May 13. Any general member of the Indiana Association who desires to attend this meeting is cordially invited to do so. There will be no outside speakers and no entertainment.

The normal business to come before an annual meeting will be transacted and the balance of the day will be devoted to a round table discussion of current problems of interest to those present.

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CARBONIZING SYSTEMS

• *boost* production

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440 CARBONIZING PLANTS, in 20 countries, testify to the outstanding advantages of GLOVER-WEST Systems.

Today, with the fate of civilization depending on the speed and efficiency of our war-output, these advantages cannot be overstressed:

GLOVER-WEST CARBONIZING SYSTEMS

- ***LOWER*** Fuel Consumption and Maintenance
- ***FACILITATE*** Operation
- ***PRODUCE*** dryer, cooler Coke
- ***REQUIRE*** less Ground Area
- ***INSURE*** greater Flexibility

Let us give you full details. WRITE:

WEST GAS IMPROVEMENT CO.

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All sizes up to 3,400 cu. ft. capacity

Meters
Diaphragms
Repairs
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Calorimeters
Wet Meters
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METER REPAIR PARTS

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ALL MAKES — ALL SIZES OF METERS

LARGEST GAS COMPANIES NOW USING OUR PARTS

SEND FOR OUR CIRCULAR ON METER REPAIR PARTS

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PLAINFIELD, NEW JERSEY

Institute of Gas Technology Adds to Research Staff

The first woman has been added to the research staff of the Institute of Gas Technology at Illinois Institute of Technology in Chicago. She is Miss Frances Estes.

Miss Estes is employed as a laboratory technician and does her work alongside the 26 men who are also on the staff. She thus successfully invades a field that hitherto has been reserved for men since the inception of the Gas Institute in 1941.

The new staff member was graduated from Kalamazoo College in 1940 with a major in chemistry. Before coming to the Gas Institute, she was employed in the laboratories of Johnson & Johnson, a surgical supplies house in Chicago.

Miss Estes' work at the Gas Institute involves largely chemical analysis. In addition to her work, she is studying for her master's degree in chemistry.

Miss Estes' work, as is nearly all of the research at the Gas Institute, is focused on projects directly related to and contributing to the national war effort.

Miss Frances Estes on Research Staff of Institute of Gas Technology.

Pacific Coast Gas Assn. Sponsors New Idea Contests

Gas company women are being asked the question, "Have you ever seen a dream cooking?" by Gladys Warren, Chairman of the Women's Committee. Three hundred dollars in prizes are at stake. This contest is the Women's Committee contribution to the program of the Association's Committee on Post-War Appliances led by W. M. Jacobs, Southern California Gas Company. Assuming that most women employed by gas companies use gas ranges in their homes and have a special interest in their functioning, the contest was planned to afford them an opportunity to register their ideas—at a profit. The Women's Committee contest is open to all women employees of member companies except home economists. It concerns gas ranges only.

Two similar contests with similar prizes are being run concurrently by the Post-War Appliance Committee. The first is directed toward home economists and sales personnel, and the second toward service department workers. These contests solicit ideas on all types of appliances. No idea is too revolutionary or too simple to be of interest to the committee. All association members are urged to help their contest director get out the vote among all eligible associates. While a large response will give the judges a tremendous headache, it will also be indicative of the vitality and intelligence of the industry.

Economic Survey Committee of N. E. Gas Association

The New England Gas Association directors at their meeting on March 17 authorized President West to appoint an Economic Survey Committee, the purposes of which are outlined in the following resolution:

"That the President be authorized to appoint a committee to study the advisability of sponsoring for the New England gas companies as a regional group the conduct of a comprehensive survey, the objectives of which would be to explore all practical possibilities for efficiencies and improvements, such as further interconnections, the development of new processes and new or expanded competitive markets so that our New England companies may be adequately prepared to anticipate post-war conditions and to cooperate to the fullest extent with each other and with other industries in adapting themselves promptly, intelligently and successfully to the economic development of New England in the post-war period."

New England District Offices of Koppers Moved to Boston

Transfer of the New England District offices of the Koppers Company, Tar and Chemical Division, from Providence, R. I., to the Boston Consolidated Gas Building, Boston, Mass., was announced March 31st by J. N. Forker, vice president of Koppers Company and general manager of the Tar and Chemical Division.

Maurice D. Gill, vice president of Koppers Company, will remain manager of the New England district. Local offices will continue to be maintained at Koppers plants at Everett, Mass., East Providence, R. I., New Haven, Conn., and Portland, Me.

Gas Range Production May Increase

Gas ranges are on the list of household items recommended to the Office of Civilian Supply of the War Production Board April 5 for wider production by a special four-man committee. Other items on the list of 200 "hard goods" include coal and wood ranges and heaters, non-electric irons, dish pans, roasters, saucepans, wash basins, percolators, double boilers and kettles. All of the cooking utensils, it is recommended, should be made of enamel.

The committee which made up the list is expected to begin at once to learn the volume of these "hard goods" and report how production compares with requirements.

Joseph L. Weiner, Director of the Office of Civilian Supply, said, "The fact that such a study is being made should not be interpreted as meaning that a lot of civilian items are going to be brought back into production, or that production of others is to be suddenly increased.

"Adequate production of essential items for civilians is an integral part of the war effort. We can't fight a total war without such items as axes, hoes, tacks, saucepans, lanterns, lamp bulbs and milking pails."

The Reliable Shut-Off for Street Mains

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E. F. Schmidt Celebrates 25 Years of Company Service

Elmer F. Schmidt

Passing his 25th milestone with Lone Star Gas Company, April 1, Elmer F. Schmidt, vice president and operating manager, joins the ranks of other executives of the company who have reached or passed the 25-year mark.

Mr. Schmidt came to Lone Star on April 1, 1918, when he took charge of the Gas Measurement Department. He has served successively as chief engineer, general superintndent, director and vice president in charge of production and transmission. Mr. Schmidt is a native of Binghamton, New York, and a graduate of Cornell university.

Other Lone Star vice presidents who have reached or passed the 25-year mark with the company are Chester L. May, a member of the company since November, 1916, which gives him a 26-year service record with the company; and R. G. Soper, who has been with the Lone Star Gas System since January 5, 1909, giving him a 34-year record.

R. A. CARTER, JR.

Robert A. Carter, Jr., manager of gas production, Consolidated Edison Company of New York, Inc., who was on sick leave from the company, died of a stroke April 2 near Tucson, Ariz., while enroute to New York. He was fifty-eight years old. Mr. Carter, who represented the third generation of his family in the service of the Consolidated Edison System, would have completed forty-one years of service with the system this fall. His grandfather, Samuel Carter, was the treasurer of the New York Gas Light Company and first treasurer of the former Consolidated Gas Company. His father, the late Robert A. Carter, Sr., was vice-president of the Consolidated Gas Company.

Born in Brooklyn, N. Y., August 9, 1884, Mr. Carter was educated in the Brooklyn public schools and later attended Pratt Institute, Euclid School and Columbia University. He started with the Consolidated Gas Company in 1902, working for two years as a stove repairman in the Customer Service Shop. By 1908 he had become assistant engineer of the Central Union Gas Company's 138th Street Station. In 1922 he was made engineer of manufacture for the Consolidated Gas Company and the Astoria Light, Heat and Power Company. He was appointed a vice-president of the Astoria company in 1928, and, following the merger of the Consolidated Gas Company and Astoria Light, Heat and Power Company into Consolidated Edison Company of New York, Inc., in 1936, he was made engineer and later manager of gas production, Consolidated Edison.

LEON JONES

Leon B. Jones, San Francisco, Calif., died in England on January 30. Mr. Jones and his father before him were the apostles of oil gas. How soundly and well they did their work was evidenced by the almost universal use of the oil gas process on the Pacific Coast prior to the discovery of natural gas. The father, Edward C. Jones, was the founder of the Pacific Coast Gas Association and for many years was its recognized leader. Leon followed in his father's footsteps, adding many refinements to the oil gas process and contributing much to the industry and this association. He won its Gold Medal in 1913 for a paper on oil gas and was vice president of the association in 1920. His latest work in this region was the design and construction of the present efficient plant of the Honolulu Gas Company. Shortly thereafter he went to England to build a plant in Wales. This plant led to others and resulted in the formation of a British company, the Jones Gas Process Co., Ltd. which occupied him until the time of his death.

SEC Orders Dropping Five Companies in New England

The Securities and Exchange Commission has directed the elimination of four subsidiary holding companies and the dissolution of a fifth in the New England Power Association holding company system. The Commission acted under Section 11 (B) (2) of the Public Utility Holding Company Act—corporate simplification.

The companies to be eliminated are the Massachusetts Power & Light Associates, North Boston Lighting Properties, Rhode Island Public Service Co., and Massachusetts Utilities Associates. The holding company ordered to be liquidated and dissolved is Massachusetts Utilities Associates common voting trust.

The Commission further ordered that New England Power and the five subsidiary holding companies shall with due diligence submit to the Commission a plan to effect prompt compliance with its orders.

All the companies are part of the International Hydro-Electric System, also a registered holding company. Last July the Commission issued a "death sentence" order against the top unit, directing that the International System be liquidated and dissolved, and further directing the company to submit a plan for its liquidation and dissolution.

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Large Gas Holder to be Converted To War Scrap

One of New York City's first large gas holders is going to do its part in the war. Consolidated Edison Company of New York, Inc., announced that a gas holder at East 12th Street, Manhattan, was to be dismantled and nearly five million pounds of iron and steel made available for the war effort. This is almost the quantity of scrap necessary in building the hull of a heavy cruiser.

Title to the holder has just been transferred to War Materials, Inc., and demolition will start this week. The company has adjusted its gas operations so that the storage requirements at this location can be handled efficiently by two other gas holders.

The holder which will become scrap is of four million cubic feet capacity, and is of the telescopic type. In 1895, when it was built, a holder of that size was considered large, whereas now Consolidated Edison has several holders of fifteen million cubic feet capacity.

The guide frame of the holder stands 200 feet above the ground.

Mixture of Oil and Coal Fuel Tests

Exhaustive tests to develop a fuel composed of a mixture of oil and coal, for years the goal of research chemists and engineers, have been started by the United States Bureau of Mines and The Atlantic Refining Company in an industrial boiler of the company at its Philadelphia refinery.

If the tests prove successful a colloidal fuel for industrial furnaces, heating plants, and poker generators, the amount of oil needed by this type of equipment will be reduced by about one-third and will be an important factor toward alleviating the serious petroleum shortage along the Atlantic seaboard. It is expected that the tests will be concluded within a month.

Past tests to determine the practicability of a coal-oil fuel have proved inconclusive. Moreover, until the war caused the present acute shortage in fuel oil, the abundance and cheapness of this type of fuel left little incentive for experimentation in colloidal fuels.

It is planned to burn 30,000 gallons of the mixture of heavy fuel oil and powdered bituminous coal in the test boiler while studies are made of methods of storage and of the effects of variations in the mixture and in combustion conditions. The mixtures used in the experiment contain approximately 60 per cent oil and 40 per cent bituminous coal pulverized into powdered form in grinding machines. The type of coal used is bituminous with a relatively low ash content. The greatest problem is to establish a mixture which will prevent the settling of coal particles and a consequent separation of oil and coal components.

Periodic Meter Testing Waived

Rules of the Pennsylvania commission requiring accuracy of gas meters within 2 per cent of error and requiring testing at least once in five years have been amended as a result of the issuance of Supplementary Order M-43-b by the War Production Board.

Gas Pressure Regulation

(Continued from page 15)

building. It can be observed that if a serious rupture occurs in the diaphragm gas will pass into the upper diaphragm case, from which point it will bleed off through the vent opening. Since any escapement of gas from this opening will be readily apparent and means can be immediately taken to correct the situation before a hazardous condition develops, it is not general practice to pipe the vent openings to an external point unless the regulator is installed in a comparatively confined space.

The vent opening is designed, as a rule, with a small orifice which leads from the threaded boss through the diaphragm case wall. This orifice is of reduced size because it provides a throttling effect to dampen out any sudden movements of the diaphragm by throttling the flow from the case or into the case.

Any possible deterioration of the diaphragm occurs at a very slow rate other than that caused by a sudden excessive surge of pressure and, consequently, any seepage of gas through a diaphragm will be very small in amount. In industrial installations regulators are generally located at a point where a small escapement of gas will not be inconvenient nor hazardous due to the large volume of space into which it may bleed, combined with the fact that the natural drafts within the space tend to carry away and discharge any seepage.

5—Relief Valves. Relief valves for the protection of the regulator are not generally installed. It is advisable to apply them only when exceptionally high supply line pressures are used. However, in such cases it is best to install multiple reduction regulators with the first stage using a high pressure regulator designed for this particular service. In some cases, two stage regulation is employed where pressures vary greatly in the supply line, combined with a requirement which necessitates close control of the pressure at the outlet of the final stage. A regulator always gives better performance for steady conditions of pressure and flow rate. Consequently, by using two stage regulation any wide variations in pressure which may occur in the piping of the plant system are reduced in magnitude so that the second stage regulator can have the advantage of fairly constant control conditions.

6—Adjustment. Regulators of small and medium capacity can be set by the manufacturer for the desired specifications and, therefore, can be placed in operation without any adjustments. Regulators of large capacity are generally set for the actual conditions occurring with each individual installation. In order to obtain the best operating conditions for the burner, it is frequently desired to change the regulator setting at the time of installation and all conventional regulators are provided with means of changing the outlet pressure setting regardless of the type of control which is employed.

7—Relation to other equipment. A regulator is not affected in any material way by other equipment or accessories with the exception of special control valves. Such control valves have come into limited use recently in plants where it is considered advisable to give protection against possible failure of the supply pressure. These valves are designed to close off when a certain minimum pressure is reached and to remain closed until opened manually. The combination of an automatic shut-off valve and gas pressure regulator should be carefully considered. Some installations have been made where this point has not been given attention with the result that difficulties have been encountered. In these cases the automatic shut-off valve has been located between the regulator and the burner equipment. Where thermostatically controlled snap action valves are used, it is possible for these valves to become synchronized in a way which causes very excessive surging to occur. For example, if several open simultaneously, the demand is such that the pressure in the line between the regulator and the burner equipment reaches a very low point. If the automatic shut-off valve is set to close at this low pressure point, it will operate and thus cut off the entire supply to the burners. If an automatic low pressure cut-off valve is deemed necessary, it should be located in the supply line at a point some distance from the inlet of the regulator, because it should not become operative unless the supply to the regulator fails. At this location it cannot, of course, be affected in any way by the sudden and excessive changes in pressure which result from simultaneous operation of automatically-controlled burner valves.

IV—Operation

1—General—The small and medium capacity regulators which are employed in general for industrial services are placed in operation without any special attention after being properly installed, and continue to perform satisfactorily without any further attention. In the large installations it is frequently necessary to check the operating conditions including the inlet pressure, outlet pressure, and regulator setting due to changes in conditions which may vary from the original specifications. Since a regulator is comparatively simple in design and construction, it seldom requires any attention during operation, but the type of service to which it is applied, combined with continuous use, may cause a departure from its original and intended performance. Other than serious mechanical damage from an external cause there is only one characteristic of a regulator which may be changed, namely, sensitivity.

2—Sensitivity. When a regulator fails to respond satisfactorily to changes in outlet pressure it lacks sensitivity and shows a sluggishness of movement of the operating parts. Such a condition can be caused only by some internal friction caused by misalignment of the parts due either to excessive strains having been placed upon them or by excessive wear which results in undue friction. The mechanical condition of the regulator can be easily determined by inspection of the parts.

It must be remembered that any criticism of regulator performance should be carefully analyzed to determine whether the cause is the result of some condition within the regulator or whether it is due to some external cause. A regulator can only control the pressure which is applied to its control mechanism and it cannot respond to any other changes which may occur in the flowing stream of gas. A regulator cannot possibly correct for a surging condition in the line which may be caused by suddenly changing either the inlet or the outlet pressure or by some turbulence of the flowing stream which affects the control pressure. Turbulence may be caused by turns in the pipe line; reduction in line size; or by valves located so near the connections, especially on the outlet, that the flow of the gas from the regulator is seriously disturbed. Ob-

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Gas Pressure Regulation

(Continued from page 56)

viously the correction for any erratic regulator performance under these conditions must be made by changing the pipe line or control point.

If a regulator is located at some distance from the burner installation, it must be remembered that any change in pressure at the burners must be communicated to the regulator before it can respond and that it can make no correction for the flow rate conditions until this change has become effective on its control mechanism. Therefore, in checking the accuracy of a regulator control, the pressure should be studied at a point adjacent to the regulator. While it is possible in practically all industrial installations to mount the regulator near the point of utilization, it may develop that a considerable length of line must be used between the regulator outlet and the burner. The performance of the regulator can be improved in many cases where this condition exists by connecting the regulator diaphragm case to a point in the pipe line near the burners so that the regulator endeavors to maintain the control at this point rather than immediately at the regulator outlet.

Sudden changes of pressure at the regulator outlet may be caused by friction or other mechanical characteristics in the regulator or by the method of controlling the gas which is flowing in the outlet line. Any sudden variation in the flow rate to the burners may cause a decided surge at the regulator. Such conditions do not reach an undesirable condition, as a rule, for burners which are manually controlled or are automatically controlled with a slow moving control valve. However, if snap-action valves are used for opening and closing the line to the burner, it is necessary to accept sudden surges of the gas pressure at the regulator outlet.

V—Maintenance

1—Regulator Inspection. Due to the fact that regulators are so thoroughly reliable and perform over a long period of time without attention it is frequently considered unnecessary to give them any attention until some difficulty develops. Such a policy cannot be considered as good practice. A gas pressure regulator is a mechanical device with moving parts, the majority of which are exceptionally rugged, although other parts such as the control diaphragm are more sensitive. The mechanical parts may become worn or eroded by foreign matter carried in the pipe lines to a point where improper performance develops. In such cases the cause of the difficulty has progressed to the point where it becomes necessary to repair the regulator. On the other hand, if reasonable attention is given to the regulator to observe any possible development of wear or erosion, steps can be taken to correct the cause of such trouble. Therefore, it is advisable to make periodic inspections of regulator equipment. The frequency of these inspections can be determined only by experience with the particular individual conditions existing in each installation. Since the movement of the operating parts is very simple, combined with the fact that regulators, as a rule, are designed for convenient examination, very little time is required for the routine inspections.

2—Spare Parts. Only experience can determine the type of spare parts which should be carried in stock for immediate use in servicing regulators. Parts are always available for prompt delivery from manufacturers and, therefore, parts should not be stocked which may deteriorate before they are required. While the diaphragms are the most sensitive parts of a regulator, they will remain in serviceable condition for a long period of time, especially if they are examined and reoiled when the first signs of dryness begin to develop. If diaphragms are carried in stock as spare parts they should be kept properly lubricated and protected against drying out to the point where they will become unserviceable if needed.

While the majority of regulators used on industrial installations have valves of the metal to metal or hard seat type, there are some cases where soft seat valves are preferred. In such cases, it may be advisable to maintain spare parts for the valve assemblies. As a rule, these parts are confined to the valve discs. Both oil-treated leather and composition materials are employed for this service. If the valve discs are of leather they should be kept properly oiled to insure that they remain in a pliable condition. Composition materials are subject to aging and should be examined periodically to determine their serviceability.

Other than breakage due to accidents or emergency conditions, the metal parts of a regulator remain in a serviceable condition indefinitely. However, if any parts become decidedly worn, it is advisable to provide for spare parts or immediately make replacements.

Manufacturers of gas regulators have available very complete information on all regulators for operating conditions usually encountered in industrial service. Complete information on design, construction, application, and performance can be readily obtained.

Operation-Time Recorders—In Bulletin A-321, The Foxboro Company, of Foxboro, Mass., presents its Operation-Time Recorders, both electric-operated and mechanical, and explains the application of such instruments to the processes of various industries. Their importance in test engineering, in setting job standards, and in cost accounting and production control is discussed, and diagrams show typical installations of Recorders for several different kinds of work. Complete specifications are included, for single- and multiple-pen instruments. Copies of the bulletin will be sent on request.

Arc Welding. A 42 page booklet, 8½ x 11, entitled "Factors Affecting Increased Welding Production" has been issued by Lincoln Electric Co., Cleveland, Ohio, being a reprint of articles on this subject appearing in the trade press during 1942.

The booklet is profusely illustrated and carries many charts and tables that are helpful in choosing the correct electrode, applying the most suitable welding technique, estimating speeds and costs of various welding jobs, and other data that will produce the best possible results, reduced costs and increased welding production.

"Doall Contour Saws" is a new 265-page textbook liberally illustrated which gives comprehensive study to the Art of Contour Machining, its cutting tools and the Doall training program. Latest techniques for Contour Machining, internal and external three dimensional parts for "short run" forgings, multiple identical parts in one operation for "short run" stampings and facilities for handling both massive or small jobs are presented as reported from the field.

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